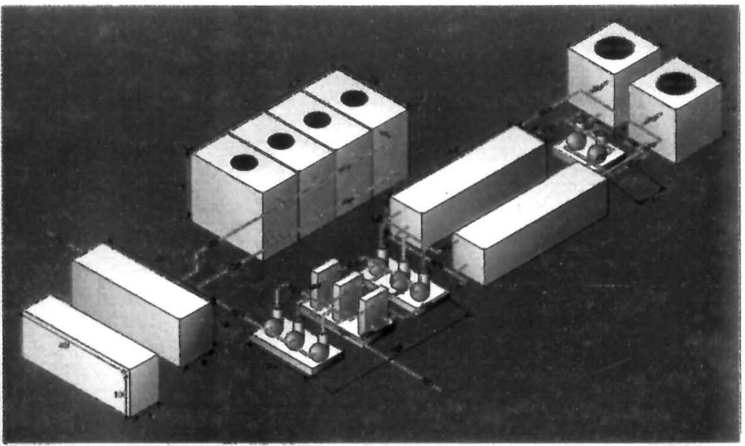
City of San Jose

ENVIRONMENTAL ENHANCEMENT PROGRAM



Coyote Creek Streamflow Augmentation Pilot Program

Project Description

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Tetra Tech, Inc.

February 1999

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Prepared For:

City of San Jose

Environmental Services Department
4245 Zanker Road
San Jose, CA 95134

Prepared By:

Tetra Tech, Inc.

3746 Mount Diablo Blvd., Suite 300
Lafayette, CA 94549
(925) 283-3771

2880 Zanker Road, Suite 203
San Jose, CA 95134
(408) 432-7277

SANTA CLARA VALLEY WATER DISTRICT
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5750 ALMADEN EXPRESSWAY
SAN JOSE, CALIFORNIA 95118

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1.0 INTRODUCTION

The City of San Jose's Environmental Enhancement Program includes streamflow augmentation and wetland creation using recycled water to help restore ecological health in the aquatic environment and to improve water management in the South San Francisco Bay Region. The Coyote Creek Streamflow Augmentation Pilot Project is the first step in testing the feasibility of using recycled water for beneficial environmental uses in the South Bay. It represents a longterm commitment to an experimental program that will determine if the release of recycled water in Coyote Creek during summer low-flow conditions can create and maintain stream conditions that enhance the aquatic environment and can support cold water fish species within the creek prior to spawning.

This document provides a preliminary project description of the Coyote Creek Streamflow Augmentation Pilot Project. The purpose of distributing the preliminary project description is twofold. The first is to provide the first concise description of the scope of the project both in terms of the basic layout and the efforts that will be conducted to demonstrate the effectiveness of the initial pilot project. The site selection process is described, followed by a description of the biological criteria that are being used to guide the establishment of flow and temperature performance criteria. Next, a detailed description is given of the cooling system that will be constructed to maintain temperature control of the recycled water prior to release to the creek. The proposed water quality and ecological monitoring efforts that will be conducted to document the resulting conditions in Coyote Creek and potential benefits of the streamflow augmentation pilot project are also described.

This preliminary project description is also being distributed to solicit comments while the final design efforts are underway. Over the next several weeks this document will be completed, and a substantial effort will be spent in determining both pre- and post-operational monitoring efforts. These design efforts include water quality, temperature, fisheries, and habitat monitoring. The comments of the members of the Environmental Enhancement Stakeholder Group are critical to the success of the pilot program. These comments will be used to produce a final project description that will either directly resolve the streamflow augmentation issues that have previously been raised, or that will adequately describe how the information that is necessary to address these issues will be developed during the course of the project. The preparation of the project description is also being coordinated with other programs, such as the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE), that are in the process of evaluating the relationship between seasonal streamflow and aquatic habitat.

2.0 SITE SELECTION PROCESS

Several sites on Coyote Creek were evaluated for use in the Stream Flow Augmentation Pilot Project (Pilot Project). The evaluations were based on physical inspections of potential sites and evaluation with a set of site selection criteria.

2.1 Site Selection Criteria

Site selection criteria have been developed by combining or expanding the 39 criteria identified by the stakeholders (Table 2-1) into eleven major items divided into three logical groups (see Table 2-2): Infrastructure, Environmental, and Permitting. The first group of criteria considers the physical characteristics of the candidate sites and addresses the engineering and economic feasibility of construction and operation of the dechlorination and cooling facilities at each site. The second set of criteria addresses the potential environmental benefits of operating the plant and discharging the cooled recycled water at each site. The third group of criteria focuses on the permitting issues associated with the construction and operation of the facility, with the discharge of recycled water to Coyote Creek, and with impacts on other adjacent or regional projects, either existing or planned.

Each site has been scored on the 39 criteria. The scoring system is as follows:

5 (excellent) – the site is most suitable with respect to this criterion
4 (preferable) – the criterion is met and the site is attractive
3 (suitable) – meeting the criterion is questionable, but the site remains viable
2 (marginal) – the criterion is not met, but it does not exclude the site from consideration
1 (unsuitable) – this criterion cannot be met and extensive effort is required to make the site workable

The selection criteria shown in Table 2-2 are described as follows:

Physical Characteristics

1. *Area Of Site*

The dimensions of the site are sufficient for the design and placement of the required components. Adequate space is available for entry and exit during construction and for routine maintenance.

Table 2-1
Streamflow Augmentation Discharge Location and Design - Stakeholder Criteria

No.	Phase	Category	Description	Definition
1	S	E-P	Allows for timely implementation	No apparent project obstacles or processes (e.g., permitting) which would cause delays in implementation during 1999 dry season.
2	S	I-CSJ	Compatibility with storm water system	Project location allows for discharge through existing storm water outlet, with point of access for SBWR inlet easily accessible.
3	S	I-CSJ	Proximity to vacant parcels or public right-of-way	Project discharge location is located on an existing utility right-of-way and/or a parcel owned by the City, District, or is readily available for lease.
4	L	I-CSJ	Ability to allow for operational flexibility	Discharge location and operation allows for flexibility in when, how and where SBWR volumes are discharged.
5	L	I-CSJ	Wetlands creation and water reuse of SJ/SC WPCP land	Discharge location and operation allows for the development of constructed wetlands on Plant land.
6	L	I-CSJ	Subsurface discharge to support wetlands	Ability to improve water quality and/or support wetland through subsurface discharge.
7	L	E	Wetlands banking potential	Ability of SBWR to develop and support constructed freshwater or brackish-water wetlands of sufficient size and values as to become a wetlands bank for mitigation purposes.
8	L	E	Wetlands banking potential	Discharge location and operation supports the criteria and goals of the City's riparian corridor policy.
9	L	E	Generates highest net benefits	Maximizes the Basin Plan's objectives for the South Bay and the Santa Clara Basin Watershed Management objectives.
10	L	E	Ability to maintain long-term commitment	The ability of the City and the District to execute long-term agreement related to water supply and project operation and maintenance.
11	B	P	Existing or planned recreational activities	The relative enhancement or detriment of a Project as it relates to public perception.
12	B	I-P	Feasibility as long-term site	Ability of pilot discharge location and operation to be at or in the proximity of a long-term streamflow augmentation site.
13	B	I-CSJ	Cost	The capital and ongoing OandM costs associated with a specific discharge location, as compared to the flow diversion and environmental enhancement benefits.
14	B	P	Public visibility profile	High or low?
15	B	P	Site-specific impacts	Impact to adjacent properties from the installation and operation of the project (e.g., noise and aesthetics).
16	B	E-P	Stream morphology and potential project impact	Impact on the surrounding riverine morphology and streambed stability from the project.
17	B	I-P	Integration with BARWRP Pilot	
18	B	I-SCVWD	Confined/unconfined aquifer	Impact of the project on the water quality of the confined and unconfined aquifer.

19	B	I-SCVWD	Proximity to stream gauge stations	Ability to measure hydraulic parameters associated with project and its impacts on the overall system.
20	B	I-SCVWD	Compatibility with SBWR system O&M	Proximity of discharge location and stormwater system inlet to existing SBWR pipeline, and the operational feasibility to maintain and operate the desired discharge.
21	B	I-SCVWD	Integrates with water supply operations	Impact of project on potable water operations of the District and water retailers.
22	B	I-CSJ	Proximity to storm outfall	Same as #2.
23	B	I-CSJ	Proximity to Recycle Pipeline	Distance of project stormwater inlet location to existing SBWR pipeline.
24	B	I-CSJ	Distance from TPS (transmission pumping station)	Distance of project discharge location from TPS (to maximize temperature reduction).
25	B	I-CSJ	Access to utilities	Proximity of discharge location to electrical and telephone utilities.
26	B	I	Compatibility with existing projects	Coordination of Project to existing related projects (e.g., BARWRP, FAHCE, GRFCP, EPI, SCVUWRP, RMP Pilot) to maximize data sharing with each other.
27	B	I	Jurisdiction	The project discharge location and stormwater inlet is within the jurisdiction of the City of San Jose.
28	B	E-P	Proximity to existing/potential wetlands site	Potential of project to be used to create or support existing wetlands.
29	B	E-WQ	Water quality impacts	a. Ability of project to improve SBWR water quality (e.g., lower temp.) prior to discharge into the river due to its design or location. B. Impact on the water quality of the receiving waters from the project.
30	B	E-WQ	Feasibility of mixing with surface water aquifer	
31	B	E-fish	Compatible with fisheries management goals	
32	B	E-fish	Type of habitat and potential impact	Ability of project to support and/or enhance existing habitat.
33	B	E-design	Number of discharge locations	Flexibility of the project to discharge from multiple locations on the stream.
34	B	E-design	Distribution of locations	Coordination of discharge location to provide maximum benefit.
35	B	E-design	Flow volume per locations	Contingent on environmental benefit and ability of SBWR to deliver supply.
36	B	E-design	Volume of local base flow	Optimum flow.
37	B	E-design	Seasonal timing and duration of flows	Coordinated to support and enhance the life history stages of cold water fisheries during dry weather season.
38	B	E	Provides other habitat benefits	
39	B	E-P	Environmental risk minimization	Ability of the projects to avoid and/or minimize negative impacts to the environment.

LEGEND
Phase: S = short-term; L = long-term; and B = both short- and long-term
Category: I= infrastructure-related; E = environmental enhancement; and P = permitting

Table 2-2
Site Selection Criteria and Results of Ranking Alternative Locations

CRITERIA	**STAKEHOLDER CRITERIA***	**RANKING**				
Physical Characteristics		**Umbarger Road**	**Capitol Expwy.**	**Singleton**	**Kelly Park**	**Williams Park**
1 Area of site	7	**3**	3	5	3	1
2 Proximity to:						
Coyote Creek	3, 12	**5**	5	3	5	5
Recycled water supply	23, 25	**5**	1	3	4	3
Existing stormwater discharge	20, 22	**5**	4	4	3	3
Electricity supply	25	**5**	4	4	4	2
Sewer line	20	**4**	4	2	2	2
Emergency water supply	36, 37, 38, 39	**3**	5	2	2	2
3 Facility construction						
Construction costs	13	**4**	2	3	3	2
Construction access	13	**5**	4	4	4	2
Site preparation	13	**5**	2	4	4	2
Utilities and services connections	14, 25	**4**	4	4	4	3
Wetlands	5, 6, 7	**2**	2	4	3	3
4 Facility operation & maintenance						
Site access	3, 10, 12	**5**	5	5	4	2
O&M costs	13	**4**	4	4	4	2
Ability to measure WQ impacts	19, 29	**5**	5	5	5	5
Ability to measure habitat impacts	19, 31, 32, 39	**5**	5	5	5	5
Suitability for long-term operation	10, 12	**3**	4	4	2	1
Permitting Issues						
5 Site ownership / jurisdiction	3	**3**	3	4	3	2
6 Zoning compatibility	8, 15	**4**	4	4	4	1
7 Permitting requirements						
Land use	8, 16	**4**	4	4	4	2
Construction	8, 16	**5**	2	4	4	2
Operation	8, 16	**5**	4	5	4	2
Discharge	8, 16	**5**	5	3	3	2
8 Public impacts						
Noise	14, 15	**4**	4	5	4	1
Aesthetics	14, 15	**4**	3	5	1	1
Discharge	16, 18, 22	**5**	4	3	2	2
9 Compatibility with existing programs						
Support from other agencies	9	**4**	3	1	2	3
Environmental Benefits	26	**3**	4	4	2	2
10 Habitats						
Enhances aquatic habitat	32	**5**	5	5	4	4
Enhances riparian habitat	8	**5**	5	5	4	4
Enhances wetland habitat/banking	5, 6, 7	**2**	2	3	2	2
11 Water quality						
Impacts on groundwater	18, 21	**5**	2	1	5	5
Turbidity	29	**4**	4	4	4	4
Temperature	29, 37	**5**	5	5	5	5
Pollutants	29, 39	**4**	4	4	4	4
Total		*147*	*132*	*134*	*128*	*93*

* See Table 2-1. Streamflow Augmentation Discharge Location and Design – Selection Criteria and Program Elements

During initial facility operations the discharge will be diverted into the sanitary sewer while testing water quality. Proximity to the sanitary sewer line also provides the opportunity to divert flow from the creek at any time during operations.

3. *Facility Construction*

Site modifications and construction will be required. Related questions include: Is fill required for site preparation? Does an access road need to be constructed? What effort and costs are involved in connecting to existing utilities and services? Is construction within the streambed or riparian reserve required?

4. *Facility Operation and Maintenance*

Access will be required for the delivery of consumable materials and for routine maintenance and operation of the facility. Routine monitoring of the plant performance and of water quality before normal operation will be necessary. Access to sampling stations upstream and downstream of the discharge is essential to monitor impacts to water quality and habitats.

Permitting Issues

5. *Site Ownership/Jurisdiction*

City ownership of the site would provide a more timely construction schedule, less negotiating, and lower costs than occupying a site on leased land. Lease negotiations for land not owned by the City would require the most time and additional costs.

6. *Zoning Compatibility*

Is a pilot facility at the site considered an appropriate land use under the zoning of the General Plan? If not, can an exception or change to the zoning requirements be obtained?

7. *Permitting Requirements*

Will set-back requirements change the proposed layout of plant components for the site? Do permit restrictions exist that can affect the construction or operation of the pilot facility? Can all permit requirements for the released recycled water to Coyote Creek be met at the site?

8. *Public Impacts*

Is the site sufficiently close to residential areas that negative impacts can be expected because of noise? Will sight walls be required? Will the evaporative plume from the cooling towers create a nuisance? Will the outfall discharge location cause a direct contact nuisance?

9. *Compatibility with Existing Programs*

Can the project be coordinated with related (existing or proposed) projects? Will the project conform to regional watershed and basin plan objectives?

Environmental Benefits

10. Habitats
Are there site-specific differences in the potential for habitat enhancements (riparian or aquatic)? What is the potential for wetland enhancement or creation? What is the potential for stream bank erosion resulting from the discharge at different sites?

11. Water Quality
Are there site-specific differences in the potential to improve water quality? What are the potential impacts on turbidity, temperature, and pollutant loads?

2.2 Evaluation of Potential Sites

These criteria were used, in conjunction with site visits, to rank five candidate locations (Figure 2-1) in order of suitability for the Pilot Project. These sites are:

- Williams Street Park
- Kelly Park
- Singleton Road
- Capitol Expressway
- Umbarger Road

The Williams Street Park site (Williams Street at Coyote Creek) has a suitable outfall location on Coyote Creek, but no suitable location for treatment facilities. The surrounding land use is single family residential. There are no commercial or industrial land uses in the vicinity.

The Kelly Park site (Senter Road at Alma Avenue) has an outfall located within a picnic area. Kelly Park allows public access to Coyote Creek. During hot summer weather, many people use the creek for recreation (even though the water quality is very poor). If it is a dry year and all the water that is flowing is coming from the recycled water outfall, then people would still be drawn to the creek and the discharge may result in an attractive public nuisance. Ironically, the recycled water is most likely of a better quality than existing conditions. An adequate facilities site is not readily available for this location.

The Singleton Road site was added as an alternative because of new information that was gathered late in the selection process. It is the only site that is within the confined/unconfined zone as defined by the Santa Clara Valley Water District. The advantages of this site are the availability of space for facilities, a suitable storm sewer outfall nearby, City ownership of the land, and a long history of groundwater monitoring at this site. However, the disadvantages are its proximity to the confined/unconfined zone, and somewhat increased distance from the source of recycled water.

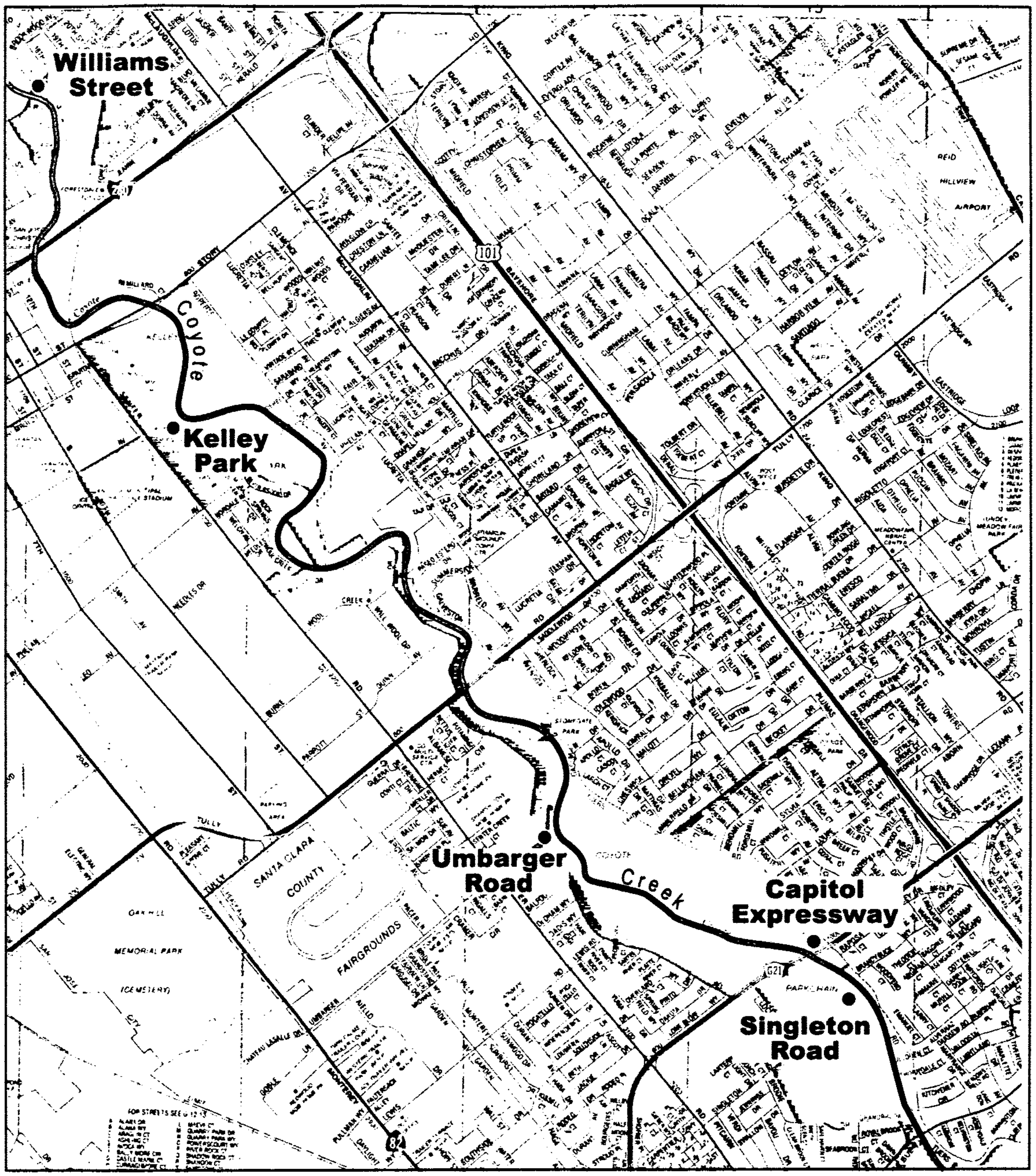


Figure 2-1. Sites evaluated for location of the pilot project.

The Capitol Expressway site (at the intersection with Tuers Road) has advantages of size, City ownership, and availability. The two major disadvantages are the low elevation (potentially in the flood plain) and the large distance (over half a mile) from the recycled water pipeline. The additional costs of importing fill and piping the water along Capitol Expressway and over Coyote Creek do not make this site suitable for a temporary Pilot Project.

The Umbarger Road site is the most suitable because of factors such as City ownership, proximity to the recycled water pipeline (about 1,000 ft), minimal additional construction costs, proximity to a storm sewer outfall, minimal public nuisance, compatible land uses, and minimal disruption of traffic during construction. The only major disadvantage is the required negotiations to finalize the facilities location (see Section 2.3). This is the preferred option for locating the Pilot Project facilities and outfall.

The ranking of each of the candidate sites according to the selection criteria is summarized in Table 2-2. This ranking resulted in the identification of a preferred location for the installation of water treatment facilities and a discharge location for the Pilot Project.

2.3 Description of the Preferred Location

A preferred water release and facilities location that best satisfies all major selection criteria has been identified along the extension of Umbarger Road, between Senter Road and Coyote Creek. It is the location that satisfies a sufficient number of criteria and therefore represents the best chance for obtaining the required in time for the Pilot Project to be operational in 1999. All other alternative locations have constraints that would prevent the Pilot Project from becoming operational in 1999.

The proposed recycled water release point to Coyote Creek is an existing 60-inch storm sewer outfall. The outfall is already operational and should only need minor modifications. The storm water line runs from Senter Road along the extension of Umbarger Road toward Coyote Creek. The extension of Umbarger Road is not a City-dedicated road. It is a narrow roadway providing access to the San Jose Conservation Corps (SJCC) and the Wildlife Rescue Center. The adjacent PG&E substation also has a gateway opening onto this access roadway.

The exact location of the facilities site has not been determined. There are currently four options for locating the facilities near the end of the Umbarger Road extension, within 600 feet of Coyote Creek and adjacent to the storm water line and outfall (Figure 2.2). This is a flat area above the flood plain. The general area consists of occupied and vacant lots. The vacant parcels contain remnants of old walnut orchards with trees approximately 12 inches in diameter and 30 ft high. The occupied parcels are owned by the City or PG&E. Part of the PG&E property is used as a power distribution substation,

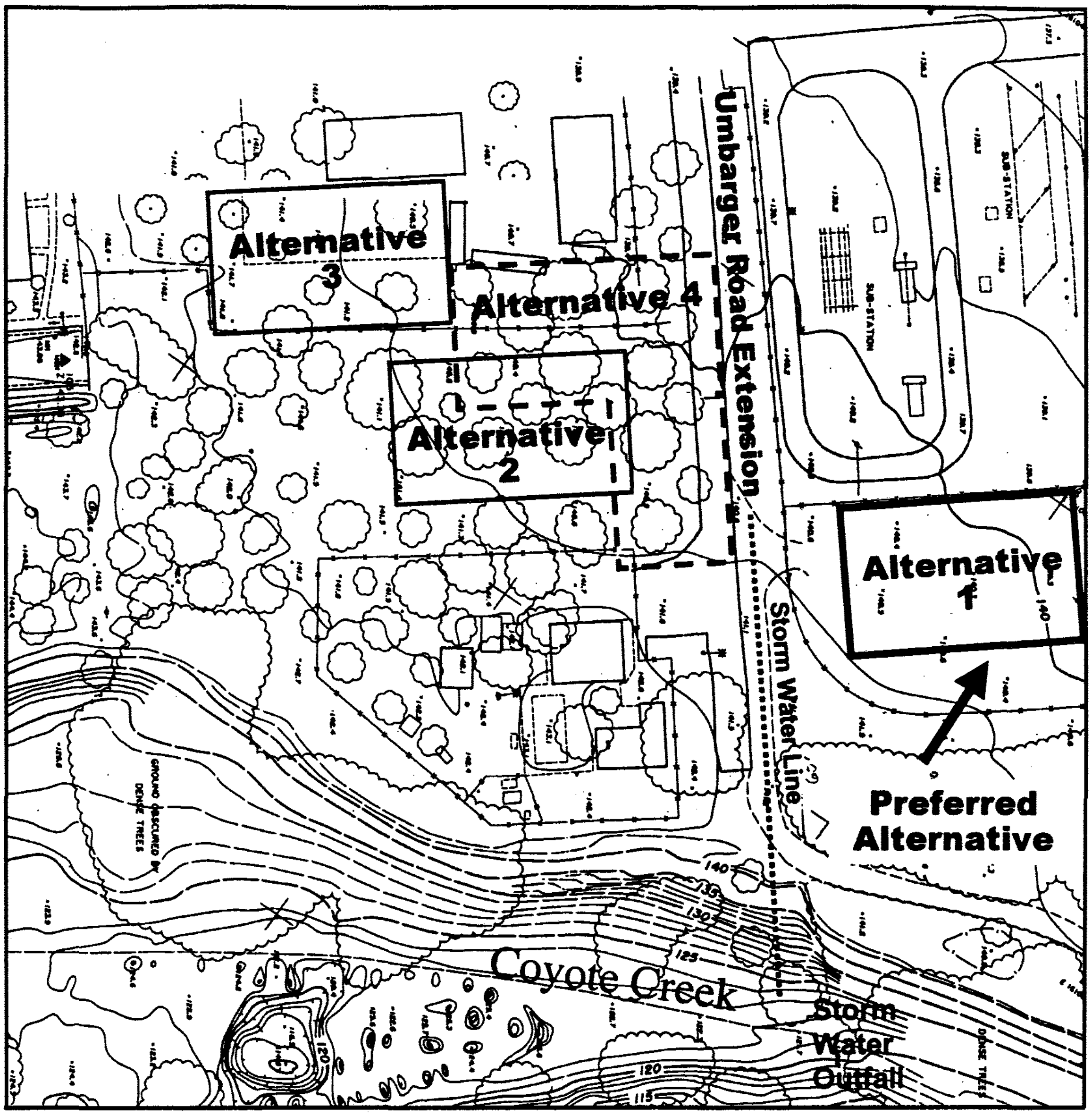


Figure 2-2. Location of preferred site.

part as a storage and parking area leased to the SJCC, and part is undeveloped land. The City-owned land is occupied by the Wildlife Rescue Center. The buildings are scheduled for demolition under a planned golf course construction project. On the other side of the vacant lot more City-owned land is leased to the SJCC. The SJCC maintains administration, storage and training buildings, and fenced storage areas.

The first and the preferred alternative location is on the property owned by PG&E, between their substation and Coyote Creek (Figure 2-2), on which the SJCC has a license agreement to store vehicles, trailers and other miscellaneous equipment. The City is currently negotiating license agreement with SJCC and PG&E to amend the existing lease.

Advantage	No need to modify golf course design
Advantage	No need to move SJCC from main location
Disadvantage	Currently leased to SJCC
Disadvantage	Need to negotiate a lease with PG&E

The second option is to site the facilities on the vacant property between the San Jose Conservation Corp and the Silicon Valley Wildlife Rescue Center (Figure 2-2). This property is owned by the City and managed by the Conventions, Arts and Entertainment Department as parkland under Parks, Recreation and Neighborhood Services. The parcel is planned to be part of the proposed Coyote Creek Golf Course Project as rough and cart trail adjacent to the 13th hole. Use of this site would require modification of the current golf course design.

Advantage	Current lack of development on site
Advantage	City ownership
Advantage	Adequate distance from residences and some tree screening
Disadvantage	Planned for use in the Coyote Creek Golf Course Project

The third alternative is the property on which the SJCC is currently located (Figure 2-2). This property is managed by the Conventions, Arts and Entertainment Department as parkland under Parks, Recreation and Neighborhood Services. The SJCC is expecting to remain on site and is planning to add a classroom and connections to sanitary services.

Advantage	City ownership
Advantage	No need to modify golf course design
Disadvantage	Currently occupied by SJCC
Disadvantage	Closer proximity to residential housing

A final alternative is to find a "best fit" between the three adjacent alternative sites. In this case the Pilot Project site jointly occupies the PG&E property (Site 1) with SJCC (there is sufficient room), or, occupies some of Sites (2) and (3), minimizing the impacts to both sites.

Advantage	City ownership
Advantage	Fewer modifications to golf course design
Disadvantage	Currently leased to SJCC
Disadvantage	Planned use of area for golf course project

The facilities footprint that is currently being designed is approximately 125 ft x 200 ft. The shape of the footprint can be modified, but a minimum area of approximately 0.55 acres is required for an 8-mgd facility. Any of the four alternative locations provide sufficient area to install all the required plant and utilities. All alternative sites are adjacent to the storm water line. The cost of connecting to other utilities (power, water, sanitary sewer, and telephone) would be approximately the same at any of the four locations.

3.0 BIOLOGICAL OPERATIONS PLAN

The biological operations plan refers to the criteria that are being developed to guide the design, operation, and monitoring associated with the streamflow augmentation pilot study. The overall objectives in specifying these biological performance criteria are to provide significant enhancement over existing conditions and minimize risks to fish and wildlife and their habitat from the proposed pilot project.

The biological criteria used are based on water temperature and stream flow conditions. Information on the acute and chronic effects of water temperature to salmon and steelhead trout, as well as stream flow requirements, were reviewed by fisheries biologists to establish biological-based operating guidelines. Temperature effects considered included tolerances of target fish to various water temperatures including short-term tolerance as well as long-term tolerance for spawning, incubation, and rearing. Flow effects considered include attraction, avoidance, stranding, and habitat preferences.

3.1 Water Temperature Requirements

Meeting specific water temperature criteria is essential. Water temperature criteria of the proposed project releases are based on meeting the requirements and preferences for various life stages of chinook salmon and steelhead. The water temperature criteria in Table 3.1 focus specifically on chinook salmon and steelhead (Raleigh et al. 1984, 1986; Rich 1987). The criteria apply to the point of release from the streamflow augmentation project into Coyote Creek.

The target release temperatures shown in Table 3.1 represent upper or near-optimal temperature limits for salmon and steelhead. These temperatures have been adopted as targets for the upper limits for the recycled water that will be released to Coyote Creek. Based on analyses of historical data, presented in Section 4, it has been demonstrated that these temperature criteria can meet in almost all cases. The maximum release stressful to salmon and steelhead over long periods of exposure, but not for short durations. The cooling system is being designed so that, even during the most extreme atmospheric conditions, the maximum temperatures will not be exceeded. As part of the design analyses presented in Section 4, the expected frequency and duration that the temperature of the recycled water will be between the target and the maximum values have been calculated.

There are two critical design conditions. The first is the ability to maintain the temperature of the recycled water below 68 °F between July and September. High ambient air temperatures at this time of the year affect the ability to cool the recycled water before it is released to Coyote Creek. The second critical design condition is the ability to meet the lower water temperatures in the spring and fall when ambient water temperatures are gradually decreasing, but air temperatures on any day can be 20-30 °F above the desired water temperature. It is the latter condition that is the more difficult to achieve.

Table 3.1
Water Temperature Criteria for Chinook Salmon and Steelhead

Seasonal Period	Target Release Temperature (°F)	Maximum Target Release Temperature (°F)	Salmon and Steelhead Lifestages
October – May	57	60	Adult holding, egg incubation, juvenile rearing
June	65	68	Juvenile rearing, emigration
July – September	68	71	Juvenile rearing

3.2 Period of Project Operation and Flows

The nominal operating period of the pilot project is from May 15 to October 15 at a stable flow rate in Coyote Creek of 8 million gallons per day (MGD) or 12 cubic feet per second (cfs). Flow in Coyote Creek after October 15 is expected to exceed 12 cfs in most winters. In the event streamflow after October 15 does not exceed 12 cfs, then project releases will continue to maintain streamflow in Coyote Creek at the base flow rate. This process is necessary to protect spawning chinook salmon and their habitat between October 15 and May 15.

Changes in discharge rates such as system startup or shutdown will be accomplished gradually under a prescribed ramping regimen developed as part of the FAHCE experimental streamflow studies to avoid the potential for stranding. This plan is designed for ramping rates (changes in streamflow over time) of 2 cfs per eight-hr. period.

3.3 Contingency Plans

In the event of any facilities malfunction, backup systems will be maintained to ensure continuation of project releases deemed essential to the well-being of the fish and wildlife dependent on the discharge. The City has identified a series of groundwater wells located upstream of the proposed discharge point that could be used as a back-up water supply in the unlikely event of a long-term plant failure or malfunction. The intent of this backup water supply system is to generally meet the same flow and temperature criteria until the plant can be brought back online to full capacity.

4.0 ENGINEERING DESIGN REQUIREMENTS AND SPECIFICATIONS

The Coyote Creek Streamflow Augmentation Pilot Project is designed to release water to Coyote Creek at temperatures below the threshold values specified by the biological criteria shown in Table 3-1. To meet these temperature requirements, cooling equipment is required to reduce the temperature of the recycled water prior to discharge to Coyote Creek by an average of between 6 °F and 12 °F, depending on the month. During mid-summer months (June to September) the recycled water must be cooled an average of 6 °F, and up to 9 °F for ten percent of the month. May and October require the greatest cooling effort. The average temperature decrease required to meet the biological criteria is 10 °F in May and 12 °F in October. For ten percent of the time in October it will be necessary to cool the recycled water by more than 14 °F.

The cooling equipment will consist of a combination of evaporative cooling towers and centrifugal chillers. The analyses described in this section were conducted to determine the number and size of the cooling units required to meet the prescribed temperatures. The steps in this analysis included:

- Definition of operating conditions
- Identification and acquisition of relevant data
- Simulation of expected ambient conditions
- Analysis of the simulation results to support required design decisions.

4.1 Pilot Project Operating Conditions

It is assumed that 8 mgd of recycled water will be released to Coyote Creek from July or August through October during the first year of operation. The maximum temperatures for the recycled water released to Coyote Creek, specified by the biological criteria, will be:

- 65 °F in June
- 68 °F from July – September
- 57 °F in October

Although the pilot project may operate over a longer period of time in subsequent years, the analyses required to determine the level and type of cooling required would not change.

4.2 Identification and Acquisition of Relevant Data

Three sets of data were compiled for these analyses. The first set consists of the ambient atmospheric data: air temperature, relative humidity, barometric pressure, and dew-point temperature. The second set contains the temperature of the recycled water. These two data sets were used in the analyses described below to determine the effectiveness of evaporative cooling towers in reducing the temperature of the recycled water and the need for and number of centrifugal chillers to augment evaporative cooling. The third set of data contains historical stream flow and water temperatures on Coyote Creek. These data were collected to provide a basis for comparing historical conditions on Coyote Creek with the enhanced conditions that will result from the pilot project.

Ambient Atmospheric Data

Ambient air temperature, relative humidity, dew point temperature, and barometric pressure recorded at San Jose International Airport were purchased from the National Climate Data Center. The airport is the closest station, approximately 6 miles from the pilot project site, at which all required parameters were recorded. Hourly data from January 1996 through October 1998 were obtained.

The data sets were edited for out-of-range-values. These out-of-range data include air temperatures greater than 102 °F, relative humidity values of greater than 100 percent, and barometric pressures equal to or greater than 9999 millibars (an instrumental error code). From July to November 1996, the relative humidity was reported at a constant value of 100 percent for all readings. These data were presumed incorrect and approximately 2,200 values of 100 percent were deleted from a total of over 19,500 data points covering the three-year period. Barometric pressure data contained extensive gaps. Data were recorded for only 25 percent of the 3-year period; no data were reported from July 1996 through June 1998.

Equipment manufacturers' performance specifications for the cooling equipment are provided in terms of wet-bulb air temperatures. Because measured ambient wet-bulb temperatures were not available, they were calculated from the ambient air temperature, barometric pressure, and the dew point temperature. Where possible, wet bulb values were also calculated using relative humidity data to check the values derived from dew point data. Differences between the two calculated wet-bulb values were less than 1 °F.

Extensive gaps also occurred in the barometric pressure data set. However, the wet-bulb calculation is not sensitive to small changes in pressure. The San Jose International Airport is close to sea level, so missing pressure data were replaced with the standard atmospheric pressure of 1013 millibars.

Recycled Water Temperature

Only recently has the temperature of the recycled water been directly measured. To make use of a larger dataset, the temperature of the final effluent from the San Jose/Santa Clara Water Pollution Control Plant was used as an estimate of the temperature of the recycled water. These data were collected from the monthly monitoring reports as a single value for each day. The time of the measurement is not reported. No other records of recycled water temperature were identified. It is assumed that the final effluent temperature is the same as the recycled water temperature before being pumped into the distribution system. Daily temperatures from January through October of 1998 were used in the calculations for each of the three years. Figure 4-1 shows the daily recycled water temperature variations and the biological criteria temperatures for the months of June through October.

Stream Temperature and Flow

Stream water temperature data are available from several monitoring stations operated by the SCVWD along Coyote Creek (Table 4-1). Water temperatures, recorded at a monitoring station at the Wildlife Rescue Center (Monitoring Site ID = 20120), were used for comparison of attainable discharge temperatures. The station at the Wildlife Rescue Center was chosen because of its proximity to the proposed pilot project discharge location. The stream temperature data were collected hourly during the summer months and cover the periods April to July 1996, July to November 1997, and June to November 1998. Figure 4-2 shows the data coverage and variation between summer months for the last three years. The figure shows that the present stream temperatures are substantially higher than the proposed biological temperature criteria and that the addition of cooled recycled water to the stream will enhance the existing environment.

Flow within Coyote Creek is monitored at two locations. The most distant stream gauge is in Morgan Hill. Data from this station are not used in these calculations. The closest to the proposed discharge site is a stream gauge at Edenvale (Monitoring site ID = STR58LMM), 3 miles upstream of the project site. Maximum and minimum flow and stage height and average daily flow are available for the period March 1946 to August 1973 (Table 4-2).

4.3 Simulation of Expected Recycled Water Temperatures

The simulation of expected temperatures of the recycled water that would be released to Coyote Creek in the pilot project was conducted in four steps.

1. All available ambient atmospheric data were used to calculate hourly ambient wet-bulb air temperatures during the months of June – October in the years 1996 – 1998.

2. The daily values for the temperature of the influent recycled water were paired with the hourly wet-bulb air temperatures.

3. The water temperature of the discharged recycled water that could be obtained using specified chiller capacities was calculated using the equations presented in Box 4-1.

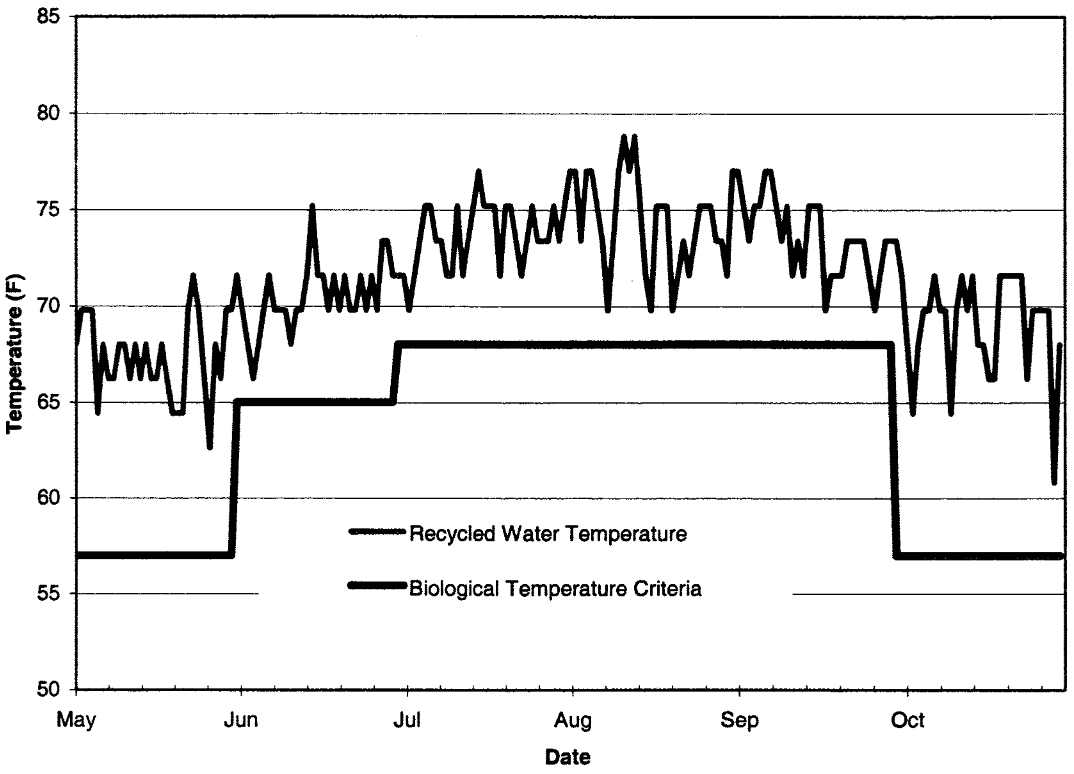


Figure 4-1. Daily recycled water temperature, 1998 and proposed biological temperature criteria.

4. In those cases for which the predicted temperature of the cooled recycled water to be released to Coyote Creek exceeded the specified biological criterion for the month, the number of occurrences and duration of each instance of non-attainment of the biological criterion were calculated.

4.4 Simulation Results

A subset of the simulation results is presented in Figure 4-3. In these plots, the temperatures of the recycled water both before and after cooling, through a cooling system with a 2,400-ton capacity, are shown along with the target biological temperature for the month of June. These results show that a 2,400-ton cooling system can reduce the temperatures of the recycled water substantially below the biological criterion temperature of 65 °F. The results of simulations conducted for cooling capacities of 1,200, 1,800, 2,000, 2,400, 3,000, or 3,200 tons for the months of June – October are presented in Appendix 1.

Table 4-1
Coyote Creek Water Temperature Monitoring Sites and Coverage

Monitoring Site ID	Monitoring Site	Distance From Pilot Project Site (miles)	Start Date	End Date
20040	Hwy 237	11 downstream	Apr-96	Oct-96
			Apr-97	Nov-97
20060	Montague Expwy	8.5 downstream	Apr-96	Oct-96
			Mar-97	Nov-97
			May-98	Oct-98
20080	Berryessa Rd	6 downstream	Apr-96	Oct-96
			Jul-97	Nov-97
20100	Coyote Creek	6 downstream	Jul-97	Nov-97
	Above U. Penitentica		Jun-98	Nov-98
20120	Wildlife Rescue Center	0 at site	Apr-96	Jul-96
			Jul-97	Nov-97
			Jun-98	Nov-98
20140	Silver Valley Ck Rd	5 upstream	Apr-96	Sep-96
			Sep-97	Nov-97
			May-98	Nov-98
20160	Silicon Valley Rd	7 upstream	Apr-96	Mar-97
			Jul-97	Nov-97
			6/3/98	7/7/98
20180	Metcalf Rd	8.5 upstream	Apr-96	Oct-96
			Jul-97	Nov-97
20200	Ogier Rd	10 upstream	Feb-96	Mar-97
			Jul-97	Nov-97
			Jun-98	Jul-98

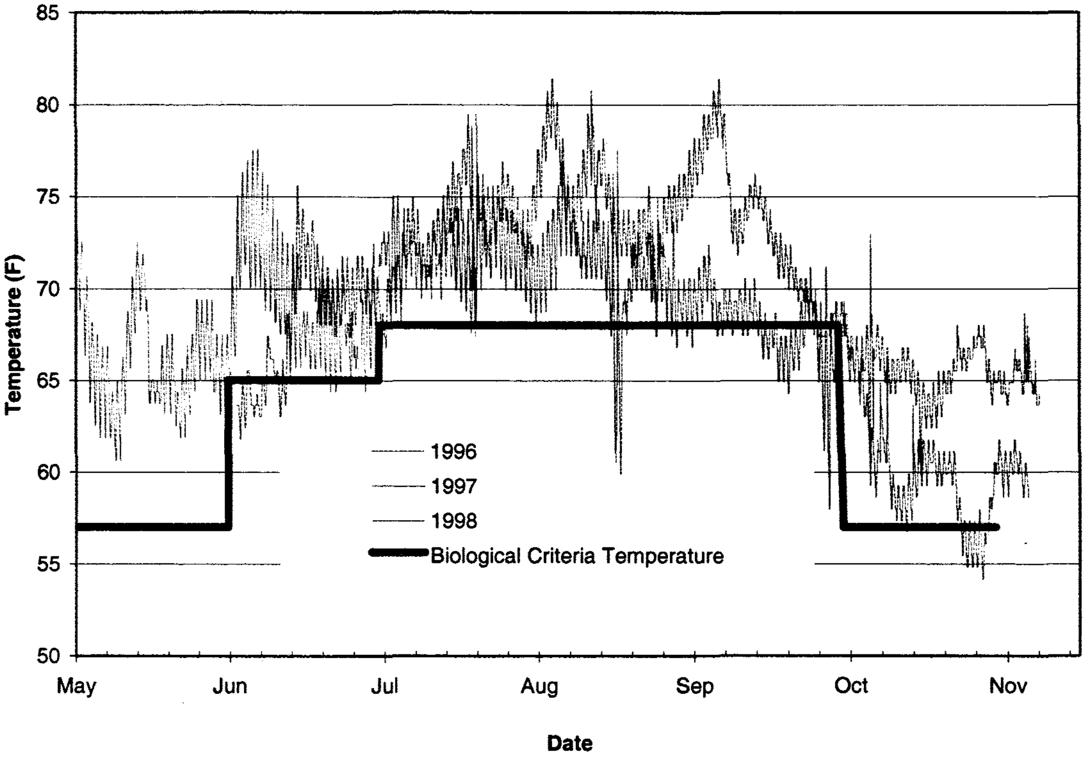


Figure 4-2. Ambient stream temperatures of Coyote Creek at Wildlife Rescue Center and proposed biological temperature criteria.

Although the results in Figure 4-3 show that the temperature of the recycled water attained with the 2,400-ton cooling system are almost always below the criterion temperature, there are times when the critical temperature is exceeded. Figure 4-4 shows the results of the analyses, to determine the magnitude, frequency, and duration of these exceedences. The temperature of the recycled water released to Coyote Creek exceeded 65 °F for one hour in simulations for June 1996. There were no exceedences for June 1997. For the June 1998 simulations, there were a total of 5 out of 720 hours during which the temperature of the recycled water exceeded 65 °F. The maximum duration of exceedence was 3 hours, and these temperatures were between 65 °F and 66 °F. Water temperatures in the simulation exceeded 66 °F for only 2 hours (non-consecutive) out of the 720 hours in the month of June.

The results of the temperature simulations are summarized in Table 4-3. The maximum number of hours in which the biological temperature criterion is exceeded is presented for each month. These results show that a chiller capacity of 2,400 tons will virtually ensure that release temperatures of the cooled recycled water will be below the prescribed biological criteria between the months of June and September. These calculations show

TABLE 4-2
Average Flows in Coyote Creek

	Spring - Summer					
Average Daily Flow (cfs)	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**
Average	70	22	11	9	6	3
Maximum	209	32	22	10	10	6
Minimum	28	15	7	6	2	1
CV	0.68	0.17	0.37	0.11	0.22	0.60

	Fall - Winter					
Average Daily Flow (cfs)	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**
Average	2	7	21	28	68	101
Maximum	3	15	33	69	174	344
Minimum	2	2	7	3	7	53
CV	0.13	0.65	0.31	0.58	0.67	0.69

that only during the month of June is the predicted release temperature expected to exceed the proposed threshold value of 65 °F. Moreover, the results indicate that the predicted release temperature will exceed the biological criterion less that one percent of the time and that the predicted duration of elevated water temperature is 3 hours or less (Tables 4-2 and 4-3).

Table 4-3 also shows that for the chilled recycled water to meet the prescribed temperature criterion in the month of October (maximum water temperature of 57 °F) considerably greater cooling capacity is required. This is because October is the month in which the greatest difference between the recycled water and the biological temperature criterion is observed. For example, the difference between the average temperature of the recycled water (69 °F) and the criterion temperature is 12 °F. In addition, the wet-bulb air temperature in October can be high (average value 55 °F; maximum 70 °F; and for one-third of the month the wet-bulb temperature is greater than 57 °F), requiring additional cooling capacity from the centrifugal chillers to reduce the temperature of the recycled water before release to Coyote Creek.

As a result of these temperature differences in the month of October, a two-staged approach is proposed for the operation of the pilot project during the first year. For the period of June to September 1999 the chiller capacity will be 2,400 tons. During this period, emphasis will be placed on monitoring the ambient atmospheric conditions, the temperature of the recycled water prior to cooling, and the performance of the water cooling facility. This monitoring information will be used to guide the selection of

BOX 4-1 Calculation of Cooling Capacity of Centrifugal Chillers

1. Background: Evaporative cooling towers will be used to provide initial cooling. Experience has shown that an evaporative cooling tower is effective in reducing water temperatures to about 4°F above the ambient air wet bulb temperature. Once the wet bulb temperature is within 4°F of the recycled water temperature, cooling towers will not perform efficiently and chiller units will be required to cool the water before discharge into Coyote Creek. Chillers are nearly independent of the ambient air wet bulb temperatures because the associated condenser water temperatures are greater than 4°F above all recorded wet bulb temperatures.

2. Nomenclature: A common unit of measure of the cooling capacity of chiller equipment is the "cooling ton". The term "ton" originates from the amount of heat needed to melt one ton of ice in 24 hours, which is equivalent to 12,000 Btu/hr.

The flow of water is measured as million gallons per day (mgd), gallons per minute (gpm), or cubic feet per second (cfs). The proposed discharge flow of chilled recycled water to Coyote Creek is 8 mgd, or 5,555 gpm, or 12.4 cfs.

3. Equations: The following equation was used to calculate temperatures and flow rates achievable from chiller units of different capacities:

$$\mathbf{Q = m \times c_p \times \Delta T} \qquad (1)$$

where: Q = heat transferred (Btu)
m = mass of water (lb_{mass})
c_p = specific heat at a constant pressure for water ($\text{Btu}/\text{lb}_{\text{mass}}/°\text{F}$)
ΔT = temperature differential (°F)

Using conversion factors for unit consistency, Equation 1 can be rewritten as

$$\mathbf{Q = gpm \times 500 \times \Delta T} \qquad (2)$$

where: the factor **500** consists of
the specific heat, $\text{Btu}/\text{lb}_{\text{mass}}/°\text{F}$ x 8.33 $\text{lb}_{\text{mass}}/\text{gallon}$ x 60 minutes per hour,
and one **gpm** is a water flow rate of gallon per minute

4. Calculations:

1. Equation (2) is used to calculate the required cooling (**Q**) to achieve the target biological criteria temperature for each month, knowing the recycled water temperatures, and assuming a constant discharge of 8 mgd.
2. An appropriate chiller capacity is selected for each summer month from the calculated range of **Q** determined in the first step.
3. Equation (2) was used again, this time to calculate ΔT, which was subtracted from the recycled water influent temperature to determine the attainable temperature of the chilled recycled water.

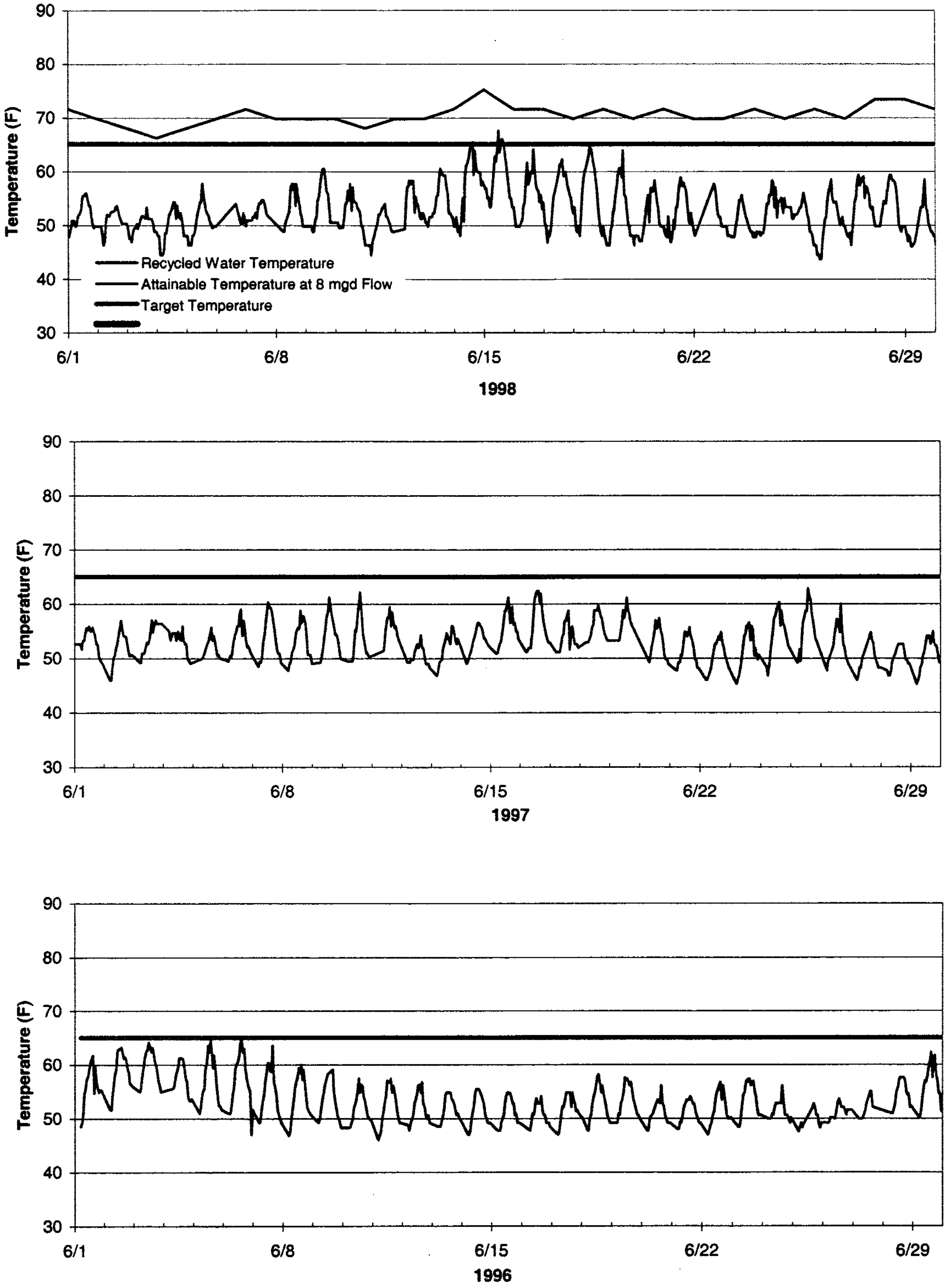
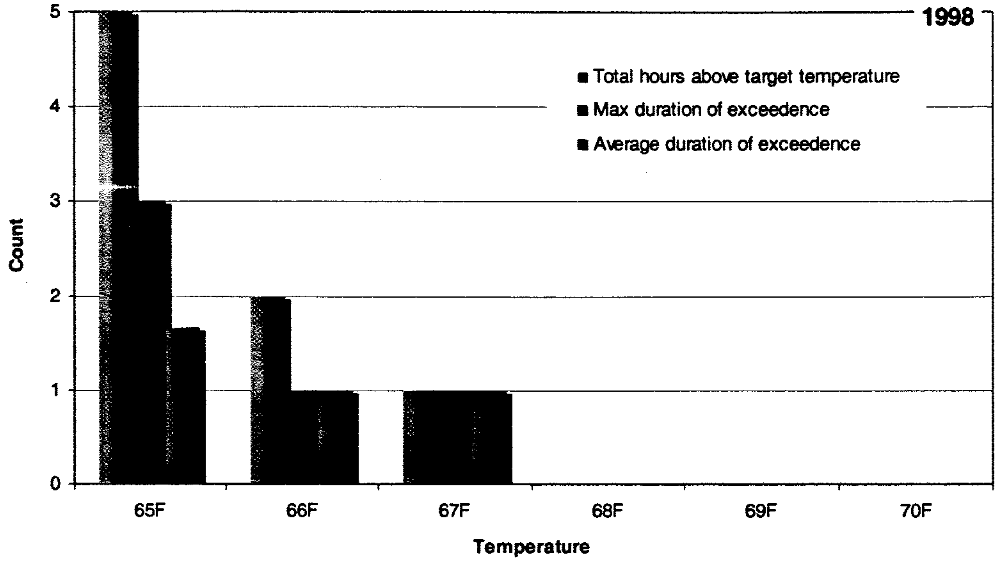
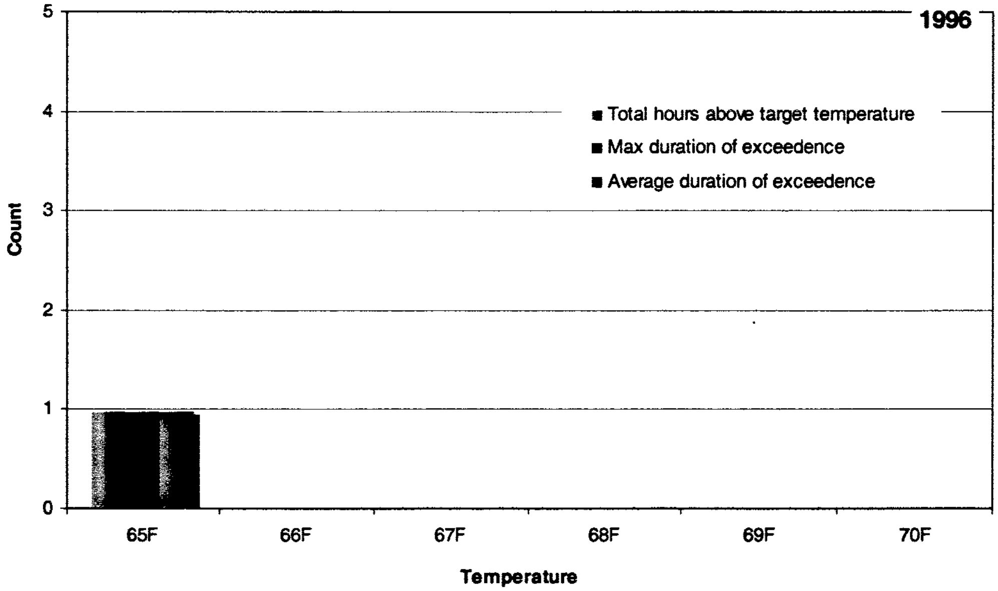


Figure 4-3. Attainable recycled water temperature for June using a chiller capacity of 2,400 tons.



June-98	65F	66F	67F	68F	69F	70F
No. of occurrences	3	2	1	0	1	0
Total hours above target temperature	5.0	2.0	1.0	0	0	0
Max duration of exceedence	3.0	1.0	1.0	0	0	0
Average duration of exceedence	1.7	1.0	1.0	0	0	0



			Temperature			
June-96	65F	66F	67F	68F	69F	70F
No. of occurrences	1	0	0	0	0	0
Total hours above target temperature	1	0	0	0	0	0
Max duration of exceedence	1	0	0	0	0	0
Average duration of exceedence	1	0	0	0	0	0

Figure 4-4. Magnitude, frequency, and duration of chilled recycled water exceeding June temperature criteria for 2,400 ton chillers.

Table 4-3
Predicted Discharge Temperatures Greater Than Biological Temperature Criteria for Selected Chiller Capacities, 1996-1998

Years 1996 to1998		**Month**				
		Jun	**Jul**	**Aug**	**Sep**	**Oct**
Temperature Criteria (°F)		**65**	**68**	**68**	**68**	**57**
Chiller Capacity (cooling tons)						
1,200	Maximum hours above criterion for one month	53	30	36	47	300
	Percentage	**7.4**	**4.0**	**4.8**	**6.3**	**40**
1,800	Maximum hours above criterion for one month	19	9	1	17	158
	Percentage	**2.6**	**1.2**	**0.1**	**2.3**	**21**
2,000	Maximum hours above criterion for one month	16	3	1	5	126
	Percentage	**2.2**	**0.4**	**0.1**	**0.7**	**17**
2,400	Maximum hours above criterion for one month	5	0	0	0	48
	Percentage	**0.7**	**0**	**0**	**0**	**6.5**
2,800	Maximum hours above criterion for one month	1	0	0	0	32
	Percentage	**0.1**	**0**	**0**	**0**	**4.3**
3,000	Maximum hours above criterion for one month	1	0	0	0	17
	Percentage	**0.1**	**0**	**0**	**0**	**2.3**
3,200	Maximum hours above criterion for one month	0	0	0	0	14
	Percentage	**0**	**0**	**0**	**0**	**1.9**

cooling equipment for future years of operation and to determine the additional chiller capacity that will be required in the month of October. Based on the analysis of these simulation data, it is estimated that the chiller will be increased to 3,200 tons by adding an additional chiller unit to the facility.

These monitoring data that will be collected at the pilot facility will be especially important in resolving several uncertainties that are associated with the design calculations that are presented in Figures 4-3 and 4-4 and Table 4-3. Foremost among these uncertainties is the temperature of the recycled water prior to cooling. We do not have hourly temperature measurements for the dry weather season. The only data currently available were measured at the San Jose/Santa Clara Water Pollution Control Plant, and these temperatures exhibited considerable daily variation. Any reduction in the recycled water temperature during the critical period of the day when the maximum wet-bulb air temperature occurs would result in an increase in the ability to cool the recycled water prior to release. For example, a time lag between the maximum air temperature and the maximum temperature of the recycled water would result in an increased ability to cool the recycled water. The transport of the recycled water from the San Jose/Santa Clara Water Pollution Control Plant via underground pipes to the pilot facility may also result in a significant cooling of the water, allowing the cooled recycled water to attain lower temperatures before release to Coyote Creek.

5.0 EXPERIMENTAL DESIGN AND MONITORING PROGRAM

The objective of the environmental monitoring program is to document the overall performance of the stream augmentation program, where program performance includes the ability to: 1) meet design criteria, 2) document permit compliance, and 3) enhance aquatic habitat and use of the creek by biota. There are three types of monitoring that will be conducted:

- Continuous *in situ* field measurements to monitoring of the effectiveness of the design, operation, and maintenance of the streamflow augmentation pilot. Both hydrologic and water quality parameters will be measured to compare design and operational characteristics. The same parameters will be measured to provide real-time data on potential acute effects to biota, e.g., changes in temperature or water quality that are deleterious.

- Field sampling at fixed intervals and locations to document the effectiveness of the stream augmentation program. Field surveys will be conducted at selected locations prior to implementing the program and at regular intervals during the course of the program. The objective of this sampling effort will be to document the long term effects of the program.

- Sampling within the immediate study area and at other locations to provide data that will link the streamflow augmentation project with the Fisheries and Aquatic Habitat Collaborative Effort and other Santa Clara Basin Watershed activities.

There are four major components to the proposed monitoring program: water quality, benthic invertebrates, fisheries, and vegetation. The initial efforts have been focused on compiling existing information, conducting a reconnaissance survey, and identifying other programs that are currently or are planning to conduct related field sampling on Coyote Creek. Based on the analysis of this information, specific sampling protocols will be developed. The following is a summary of the initial monitoring design efforts.

5.1 Water Quality Monitoring

The water quality monitoring program will address both surface- and groundwater issues.

5.1.1 Surface Water

A reconnaissance survey was conducted on November 2-3, 1998. The field crew established 3-5 transects at four sampling stations. At each station, water temperature, dissolved oxygen, electrical conductivity, stream channel profile, water surface level, water depth and velocity were measured. Additional water quality data for Coyote Creek were obtained from the Santa Clara Water District; Phase I Stream Flow Augmentation for the South Bay Water Recycling Project (Parson's Engineering Science. May, 1996);

Coyote Creek Monitoring Draft Report of South Bay Recycling TPS Pump Test. Coyote Creek Test (December 15, 1997); EPA STORET database (data from studies performed by various researchers on Coyote Creek between 1979 and present); and unpublished data from samples collected by the SJSC WPCP staff between 12/30/92 and 9/9/97 and during the summer of 1998 (Table 5-1). For comparative purposes, recycled water quality data (Table 5-2) have been obtained from the South Bay Water Recycling Program and the City of San Jose WPCP monthly Self Monitoring Reports (1997 and January - October, 1998).

A comparison of the ambient water quality of Coyote Creek to the water quality of SBWR recycled water (Tables 5-1 and 5-2) reveals that the overall water quality of the recycled water is of equal or higher quality in several instances (e.g., turbidity, pH, dissolved oxygen minima, alkalinity, BOD, TOC, TSS, coliform, and several metals; Tables 5-1 and 5-2). The recycled water has the potential to enhance Coyote Creek water quality. In addition, increased creek flows will help to eliminate "hot-spots" in the Creek through flushing. There are, however, some special conditions that deserve attention:

- **Nutrients** - While there are no numerical guidelines for nutrients (i.e., nitrogen and phosphorous), except for unionized ammonia (which is treated as a toxicant), there are narrative guidelines. The Basin Plan (San Francisco Bay Regional Water Quality Control Board, 1995) states that, *"Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses...Irregular and extreme levels of chlorophyll a or phytoplankton blooms may indicate exceedance of this objective and require investigation."* The water quality data presented in Table 5-2 indicate that total nitrogen and phosphorous concentrations exceed the concentrations that have historically been found to occur in Coyote Creek. These data indicate that there is the potential for biostimulation.

- **Ammonia** - Unionized ammonia is toxic to aquatic organisms especially fish. The Basin Plan (1995) states, *"The discharge of wastes shall not cause the receiving waters to contain concentrations of un-ionized ammonia in excess of the following limits (in mg/L as N): Annual Median = 0.025; Maximum in Lower Bay = 0.4."* The average concentrations of unionized ammonia in both Recycled Water and Coyote Creek are fairly similar (i.e., <0.009 and 0.005 mg/L as N, respectively) and therefore, do not appear to exceed either the Annual Median concentration of 0.025 or the Maximum allowed concentration of 0.4 mg/L as N. There is reason for concern however, because, for both waters, the maxima exceed 0.025 mg/L as N, which demonstrates that the unionized ammonia concentration has the potential to exceed the Basin Plan Objectives (depending upon the frequency of exceedances).

Table 5-1
Coyote Creek Water Quality Information

	Coyote Creek[1]		Coyote Creek[2]	
Parameter	**Mean**	**Maximum**	**Mean**	**Maximum**
Temperature (°C)	14.4	28	21.2	24.9
Flow (Inst-CFS)	84.5	5900	–	–
Turbidity (NTU)	30.4	410	29	35
Conductivity (μmHOS)	395.7	1650	687	1178
DO (mg/L)	8.7	2.8 (minimum)	7.1	6.0 (minimum)
DO (% Saturation)	83.7	28.9 (minimum)	–	–
pH	7.9	8.9	8.0	8.3
Alkalinity (mg $CaCO_3$/L)	148	309	–	–
Ammonia (total) (mg-N/L)	0.1339	0.37	0.16	0.26
Unionized Ammonia[3] (mg-N/L)	0.003	0.049	0.007	0.026
$NO_2 + NO_3$ (mg-N/L)	0.60	5.6	–	–
Organic Nitrogen (mg-N/L)	0.84	2.7	–	–
Nitrate (mg-N/L)	2.83	16	1.7	–
Nitrite (mg-N/L)	0.03	0.75	<0.1	<0.1
Total Phosphorous (mg-P/L)	0.09	0.64	0.37	–
Orthophosphate (mg-P/L)	0.08	0.71	0.03	–
BOD (mg/L)	1.3	1.8	–	–
TOC (mg/L)	4.78	8.7	–	–
DOC (mg/L)	5.48	37	–	–
TDS (mg/L)	231.5	1370	300	–
TSS (mg/L)	–	–	29	34
Total Coliform (MPN/100ml)	13,379	320,000	9,000	9,000
Fecal Coliform (MPN/100ml)	821	22,000	–	–
Total Hardness (mg $CaCO_3$/L)	167	1,000	186	–
Arsenic (dissolved) (μg/L)	1.3	3	–	–
Cadmium (dissolved) (μg/L)	0.9	5	<0.5 (total)	<0.5 (total)
Chromium (dissolved) (μg/L)	5.3	10	5.4 (total)	7.6 (total)
Copper (dissolved) (μg/L)	1.9	9	3.0 (total)	4.0 (total)
Lead (dissolved) (μg/L)	2.5	6	2.0	–
Mercury (dissolved) (μg/L)	0.2	1.9	0.01 (total)	0.015 (total)
Nickel (dissolved) (μg/L)	45	100	11 (total)	15 (total)
Silver (dissolved) (μg/L)	1.0	1.0	–	–
Selenium (dissolved) (μg/L)	1.0	1.0	<0.3 (total)	<0.3 (total)
Zinc (dissolved) (μg/L)	12.1	50	28 (total)	38 (total)

[1] From: EPA STORET Data base of studies performed on Coyote Creek (1979 - present).

[2] From: Phase I Stream Flow Augmentation for the South Bay Water Recycling Project (Parson's Engineering Science. May, 1996); Coyote Creek Monitoring Draft Report of the South Bay Recycling TPS Pump Test. Coyote Creek Test (December 15, 1997); and unpublished data from samples collected by SJSC WPCP staff during the summer of 1998.

[3] Calculations based on the dissociation of ammonium ion in aqueous solution.

Table 5-2
South Bay Water Recycling Water Quality Information

	March 1994 – August 1998[1]		1997[2]		1998[3]	
Parameter	**Average**	**Maximum**	**Average**	**Maximum**	**Average**	**Maximum**
Temperature (°C)	21.8	26.4	–	–	20	26
Turbidity (NTU)	1.0	3.0	–	–	1.2	4
Conductivity (μS/cm)	1304	1465	–	–	1140[1]	–
DO (mg/L)	5.5	5.4 (min.)	7.4	6.7 (min.)	7.3	5.3 (min.)
pH	7.2	7.4	7.2	7.3	7.3	7.5
Alkalinity (mg $CaCO_3$/L)	157	219	–	–	–	–
Ammonia (mg-N/L)	1.1	1.7	1.0	1.2	<1.1	1.9
Unionized Ammonia[4] (mg-N/L)	0.008	0.026	–	–	<0.009	0.035
Nitrate (mg-N/L)	13.3	22.9	11.3	15.6	7.5	14.5
Nitrite (mg-N/L)	0.1	1.8	–	–	–	–
Phosphate (mg-P/L)	–	–	–	–	3.9	9.0
Orthophosphate (mg-P/L)	5.5	10.5	4.9	8.0	–	–
BOD (mg/L)	2.7	6.0	<3	3	4	9
TOC (mg/L)	6.7	15.0	–	–	–	–
TDS (mg/L)	782	869	–	–	–	–
TSS (mg/L)	1.1	6.7	<1.1	<1.4	<2	13
Total Coliform (MPN/100 ml)	2.5	8.9	2.4	3.2	<4.3	80
Hardness (mg $CaCO_3$/L)	252	329	–	–	–	–
Arsenic (μg/L)	1.4	10	<2	10	<1.1	2
Cadmium (μg/L)	1.0	5.0	<0.5	<0.5	<0.5	<0.5
Chromium (μg/L)	0.8	2.0	<0.9	1.5	<0.8	2.0
Copper (μg/L)	4.2	6.7	4.3	6.4	3.6	8.8
Lead (μg/L)	1.1	2.0	<1.0	2.0	<1.0	1.0
Mercury (μg/L)	0.09	0.2	0.002	0.004	0.004	0.009
Nickel (μg/L)	7.7	13	8	9	6	9
Silver (μg/L)	1.0	1.0	<1.0	<1.0	<1	<1
Selenium (μg/L)	–	–	0.4	0.8	<0.4	0.76
Zinc (μg/L)	49	75	52	62	51	78
PAHs (μg/L)	–	–	4.17	4.18	<3.23	<3.88
Residual Chlorine (μg/L)	–	–	0.0	0.0	0.0	0.0
Total Fats, Oil & Grease (mg/L)	1.7	4.0	<2.4	4.0	<2.2	3

[1] From: South Bay Water Recycling Water Quality Information 10/6/98.

[2] In: Combined December 1997 and annual 1997 Self Monitoring Report (1/20/98). City of San Jose WPCP.

[3] From: Monthly Self Monitoring Reports (January - October, 1998). City of San Jose WPCP.

[4] Calculations based on the dissociation of ammonium ion in aqueous solution.

Water quality sampling will be conducted from April through October, or longer, depending on the initiation of the wet season. Three primary sampling stations are planned: one upstream of the pilot plant and two downstream. Two types of sampling will be conducted (i.e., continuous and intermittent). The continuous measurements, at the upstream and downstream stations, will be taken for temperature, dissolved oxygen, pH, residual chlorine concentration, and water level. The intermittent samples will be taken at periods ranging from several (3-4) times daily (e.g., un-ionized ammonia and turbidity), weekly (e.g., nutrients (nitrogen and phosphorous) and TDS), to monthly (e.g., metals and pesticides). Other water quality parameters such as BOD, may be included in the suite of those parameters more frequently analyzed if it is determined that there is sufficient risk of impairing beneficial uses or exceeding Basin Plan Water Quality Objectives.

Salinity will be measured at the mouth of Coyote Creek prior to and during the operation of the Pilot Project to determine the effect of the recycled water releases in the estuary. In addition, flow and water quality samples will be collected periodically from other major drainage inflows into Coyote Creek 2-3 times each season to characterize their contributions of nutrients, BOD, and potentially toxic chemicals.

5.1.2 Groundwater

One of the criteria used to select the location of the pilot project site was the potential impact on groundwater quality. The impact on the deep aquifer, which is a potable water supply, was the primary concern. For this reason, the only sites considered were those located outside the unconfined aquifer zone, where recharge of the deep aquifer occurs. However, the potential for infiltration of the recycled water released in Coyote Creek to the shallow aquifer within the confined zone still exists.

The potential for infiltration into the shallow aquifer is dependent upon streambed sediment characteristics, stream bottom profiles, extent and type of vegetation within the stream, water depth and stream velocities. Anecdotal information on flow rates in Coyote Creek from reconnaissance surveys in 1998 do not indicate that infiltration is a major concern. However, only a few measurements were made, and the flow conditions (approximately 5 cfs) were quite different from those that are expected to occur during the operation of the pilot project (flows increased by up to 12 cfs).

Two monitoring efforts will be conducted to address the issue of impact to the shallow aquifer. First, streamflow measurements will be made at several locations downstream of the pilot site to determine the rate of gains or losses in the stream and the potential for infiltration. Second, existing shallow wells in the vicinity of Coyote Creek downstream from the pilot project will be monitored before and after the initiation of releases of recycled water. The primary monitoring parameters will be TDS and nitrate concentrations.

5.2 Fish Monitoring

A major objective of the streamflow augmentation pilot program is to evaluate the ability to enhance and restore steelhead and chinook salmon habitat in Coyote Creek through flow augmentation. Fish monitoring will focus on assessing the effects of project releases on (1) steelhead and chinook salmon habitat use, (2) "attraction flows", and (3) resident fish populations.

5.2.1 Steelhead and Chinook Salmon Habitat Use

Fish habitat in Coyote Creek is expected to change both seasonally and with project release. Therefore, habitat in Coyote Creek will be monitored at least seasonally before and after project implementation. In November 1998, fish habitat was evaluated on Coyote Creek downstream of Capitol Expressway (Jones & Stokes, 1998). Baseline habitat data (i.e., prior to flow augmentation) were collected at two treatment (T1 and T2) and two control (C1 and C2) sampling stations located within one mile downstream and upstream, respectively, of the proposed site of augmentation flow release near Umbarger Road (Figure 5-1). Additionally, general habitat types (i.e., pool, riffle, and run) and potential barriers to fish passage in the entire reach of Coyote Creek from Capitol Expressway downstream to Dixon Landing Road have been identified. This information will be reevaluated/assessed prior to the pilot project startup in 1999.

The proposed monitoring program includes surveys of both adult and juvenile steelhead and chinook salmon. These surveys are intended to determine the timing, location, and extent of habitat use by steelhead and chinook salmon in Coyote Creek, and how the proposed project releases may alter these patterns. In October 1998, the City of San Jose conducted fish sampling both upstream and downstream from the project release site, at 15 locations on lower Coyote Creek (Cressey, 1998). Neither steelhead nor chinook salmon was collected. But steelhead or rainbow trout are known to be present in upper Coyote Creek and in tributaries such as Penetencia Creek (Aceituno et al. 1976; Scoppettone and Smith 1978). At least two fall-run adult chinook salmon were observed in lower Coyote Creek in 1998.

The monitoring objectives for steelhead and chinook salmon habitat use include:

1. ***Evaluation of the ability of the project release to influence the temperature regime and other water quality characteristics in Coyote Creek.***

Thermographs will be used to quantify the distance downstream from the project discharge that water temperature is suitable for salmonids. Other water quality constituents (e.g., dissolved oxygen (DO), ammonia, etc.) will be monitored in conjunction with the water quality sampling program to insure that they remain at levels suitable for aquatic organisms.

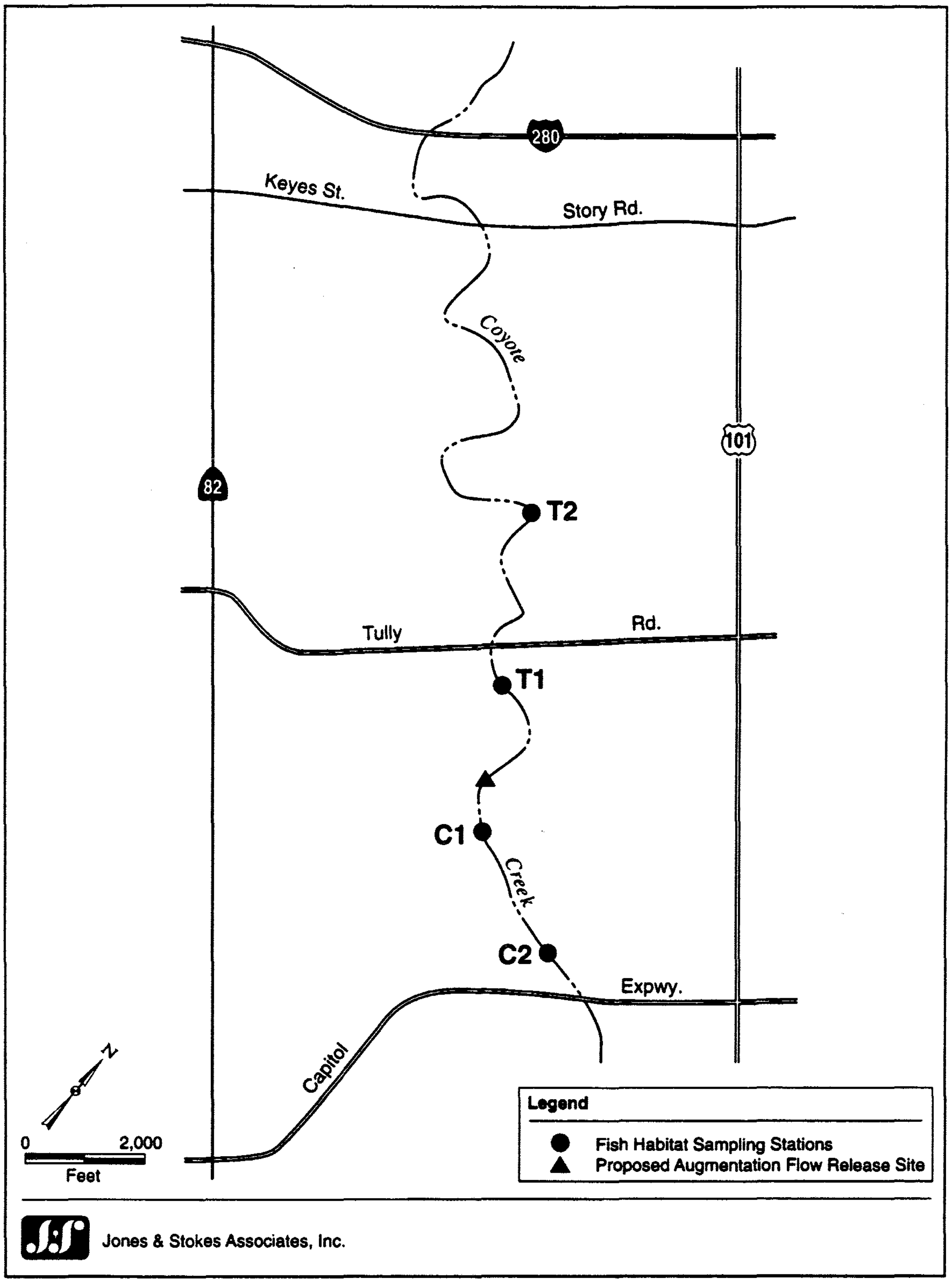

280
Keyes St.
Story Rd.
Coyote
101
82
T2
Tully
Rd.
T1
C1
Creek
C2
Expwy.
Capitol
N
0
2,000
Feet
Legend
● Fish Habitat Sampling Stations
▲ Proposed Augmentation Flow Release Site
Jones & Stokes Associates, Inc.

Figure 5-1. Location of fish habitat sampling stations established on Coyote Creek (Santa Clara County) on November 2-3, 1998.

2. Evaluation of the effects of the project release on fish passage.

The flow at which shallow riffles and artificial structures previously identified as potential barriers may impede adult steelhead and chinook salmon passage will be determined (e.g., using the methods of Thompson [1972] or Powers and Orsborn [1985]) and compared with the flow present both with and without flow augmentation.

3. Evaluation of effects of the project release on weighted usable area (WUA) of optimal rearing habitat for steelhead and chinook salmon.

The instream flow incremental methodology (IFIM) will be applied to data collected from treatment and control sites (Figure 5-1), and results from sites T1 and T2 will be compared with sites C1 and C2. This information will be used to calculate changes in stream depth and velocity patterns in Coyote Creek due to the project release.

4. Evaluation of effects of the project release on the types, quantity, and quality of habitat available in Coyote Creek.

The methods of the Fisheries and Aquatic Habitat Collective Effort (FAHCE) study team, McCain et al. (1990), and Montgomery and Buffington (1997) will be used to quantify changes in types (e.g., pool, riffle, run, etc.), surface area, gradient, and other characteristics (e.g., water depth and velocity, substrate and cover types etc.) of available habitat in selected study reaches.

5. Evaluation of effects of the project release on steelhead and chinook salmon spawning habitat use in Coyote Creek.

Five large (i.e., > 50 ft in length) locations containing gravel suitable for spawning have been identified downstream of the project release location. These areas will be monitored for the presence of redds (i.e., salmonid spawning nests) during peak spawning periods (i.e., February-March for steelhead; October-November for chinook salmon) both before and after project implementation. The project release may lead to increased spawning upstream of the release site due to improved conditions for adult salmonid migration through the project reach (i.e., decreased temperatures and increased flow). Spawning habitat upstream of Capitol Expressway will be monitored as part of the FAHCE process.

6. Evaluation of effects of the project release on habitat use and outmigrant timing.

Juvenile steelhead and chinook salmon will be surveyed with the same methods used for sampling resident fishes (see Resident fish populations, below). No juvenile steelhead or chinook salmon were collected in lower Coyote Creek during the October 1998 sampling because few or none were present. This sampling will be continued at least twice annually before and after project implementation. Sampling for juvenile salmonids upstream of Capitol Expressway will occur as part of the FAHCE process. Outmigrant traps will be set in key locations (e.g. high-velocity, narrow channels) of the project area during March-April and February-March in an effort to collect steelhead and chinook salmon, respectively. These traps will collect individuals that utilize rearing habitat both in and upstream of the project area. Targeting outmigrating juveniles should increase the number of steelhead and chinook salmon collected, and therefore allow project effects to be more appropriately evaluated.

5.2.2 "Attraction Flows"

The cool temperatures of the project release could trigger early (i.e. summer) upstream migration of chinook salmon that may be present in San Francisco Bay, but normally wait until fall to migrate into streams. The early migrants (or their eggs) could die if temperatures then fluctuate upward in a late-summer heatwave. The likelihood of such improper "attraction flows" occurring will depend on the ability of the project release to influence the temperature regime of Coyote Creek (see steelhead and chinook salmon habitat use, Objective 1, above). Monitoring will occur to achieve the following objective:

Determination of the occurrence of improper "attraction flows" caused by the project release.

The potential for "attraction flows" is dependent on the temperature of the water as well as flow at the mouth of Coyote. Initially, water temperatures and flow will be monitored along the length of the creek to determine the potential for early attraction of adult chinook. If it is determined that this potential exists, the study area will be monitored for adult chinook salmon.

5.2.3 Resident Fish Populations

Resident fish were collected in large numbers at 15 locations on lower Coyote Creek in October 1998 (Cressey, 1998). Sampling is proposed to continue using similar methods and survey design at least twice per year including at least once before project implementation. Results of these and other fisheries investigations will be compiled and analyzed to evaluate whether changes in species abundance and composition have occurred as a consequence of the proposed project. Monitoring objectives include:

1. ***Evaluation of effects of the project release on the abundance of native fishes (e.g., Sacramento sucker, hitch, and California roach).***

Many of the native species have broad temperature tolerances and, like steelhead and chinook salmon, utilize gravel riffles for spawning (Moyle 1976). Although the project releases are not expected to negatively impact native species, species composition and fish abundance will be monitored, throughout the project.

2. ***Evaluation of effects of the project release on the abundance of introduced fishes (e.g., largemouth bass and green sunfish).***

Non-native, resident fish are common and compete with or prey on native fishes (Moyle 1976); thus, any increases in their populations due to the project release would be undesirable. Because most are warm water fish and spawn in quiet water, project releases are not expected to improve habitat for these species. Fish monitoring will include the determination of the numbers of introduced fish at selected sampling stations.

5.3 Benthic Invertebrate Monitoring

The objective of this monitoring effort is to document the existing benthic community and assess changes in community diversity, structure and density. The samples from a survey of 15 sites on Coyote Creek that was conducted in September 1998 have been analyzed. The results from these analyses are presented in a recent report (Jones and Stokes Associates, 1998) and are being used to guide the design of this component of the monitoring program. Although the monitoring program is currently under development, the following is the preliminary design.

Macroinvertebrate samples will be collected from 5-15 stations along Coyote Creek. These samples will be collected following the standard EPA Bioassessment Protocol, using a standard kick seine. First year sampling will occur once in spring (late April to early May), once two to five days prior to discharge of the treated effluent, once one to two weeks after discharge of the treated effluent, and once 6 weeks after the pilot project startup. Qualified invertebrate ecologists will identify the invertebrates from each sample to the lowest practicable taxonomic level using standard taxonomic references. The invertebrates from each sample will be enumerated, and the volumetric displacement of the sample measured and recorded. Sample data will be compared to establish diversity, species richness, abundance, and to develop community indices.

5.4 Vegetation Monitoring

The release of recycled water to Coyote Creek creates the possibility of increased plant growth (algae, duckweed and emergent plants) due to increased nutrient concentrations. The proposed monitoring program will focus on documenting the habitat conditions at monitoring stations upstream and downstream of the proposed discharge location. The vegetation monitoring will be conducted in conjunction with the water quality monitoring program Nutrient concentrations will be measured at each vegetation sampling station. Permanent transects will be established at each station to quantify the changes in the areal coverage of duckweed and emergent plants. In addition, a periphyton monitoring program will be initiated to determine the effect of the recycled water release on algal productivity.

Periphyton is the attached microorganism community, including algae, zoogleal and filamentous bacteria, attached protozoa, and rotifers that live attached to exposed surfaces in the water column. A standard periphyton sampler with artificial substrates as described in Standard Methods for the Examination of Water and Wastewater (Greenberg et al., 1992) will be placed in riffle and pool sampling stations upstream and downstream of the discharge point. The sample analyses will include the measurement of chlorphyll and pheophytin, as well as dry and ash-free weight measurements. Sampling will begin one month prior to the initiation of the streamflow augmentation project and continue for one month following the cessation of recycled water releases in the fall.

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APPENDIX

June

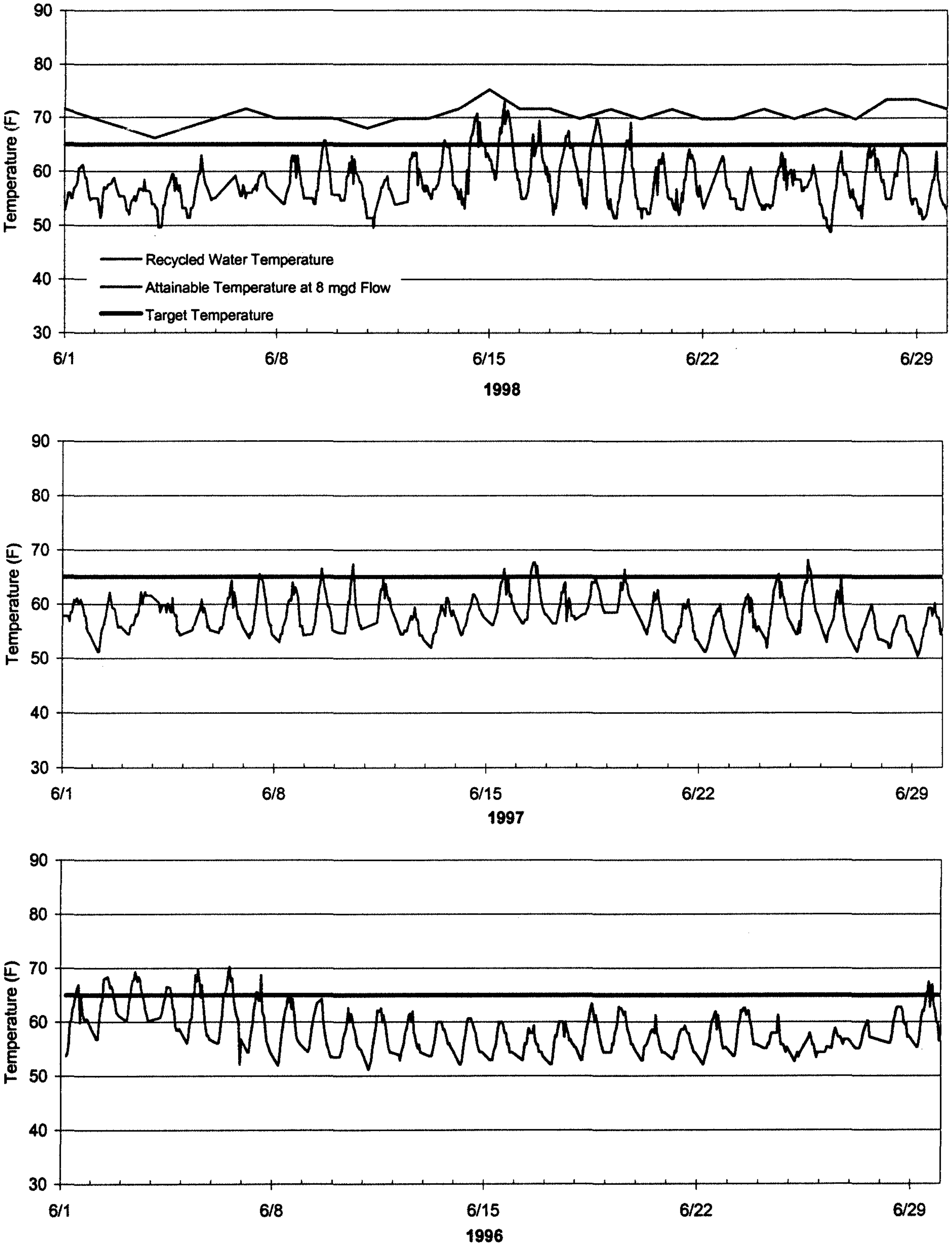


Figure A-1. Attainable Recycled Water Temperature for June Using a Chiller Capacity of 1,200 tons

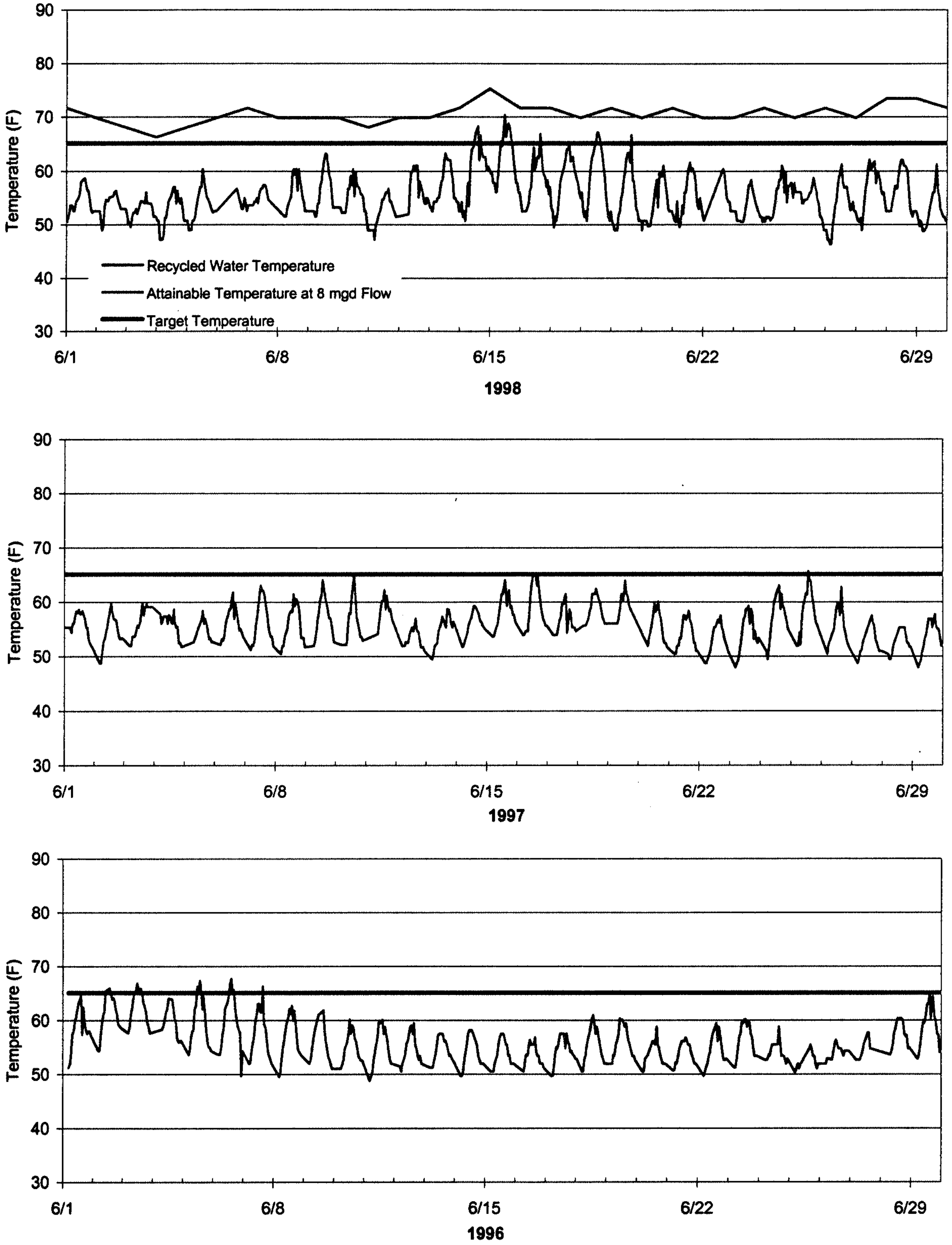


Figure A-2. Attainable Recycled Water Temperature for June Using a Chiller Capacity of 1,800 tons

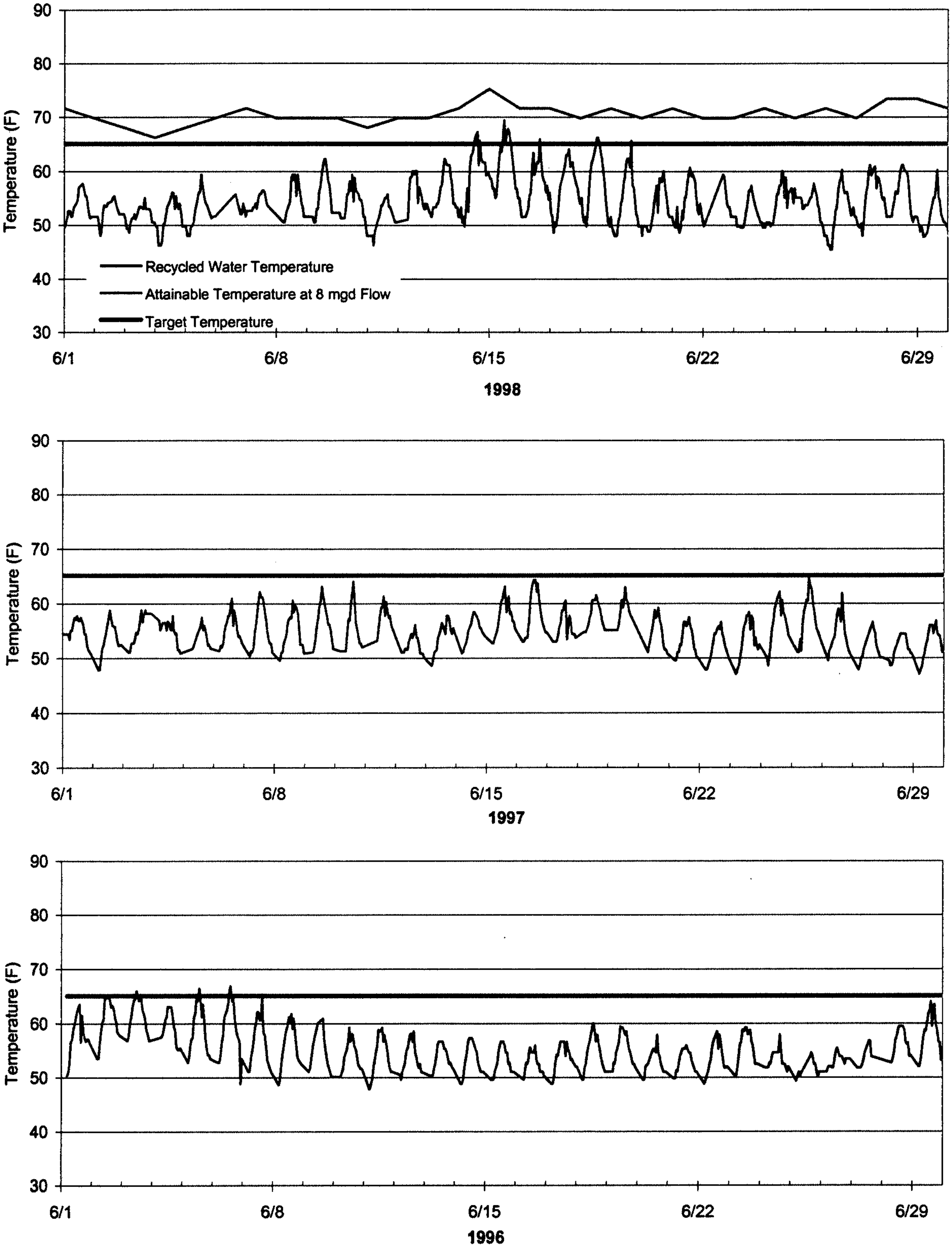


Figure A-3. Attainable Recycled Water Temperature for June Using a Chiller Capacity of 2,000 tons

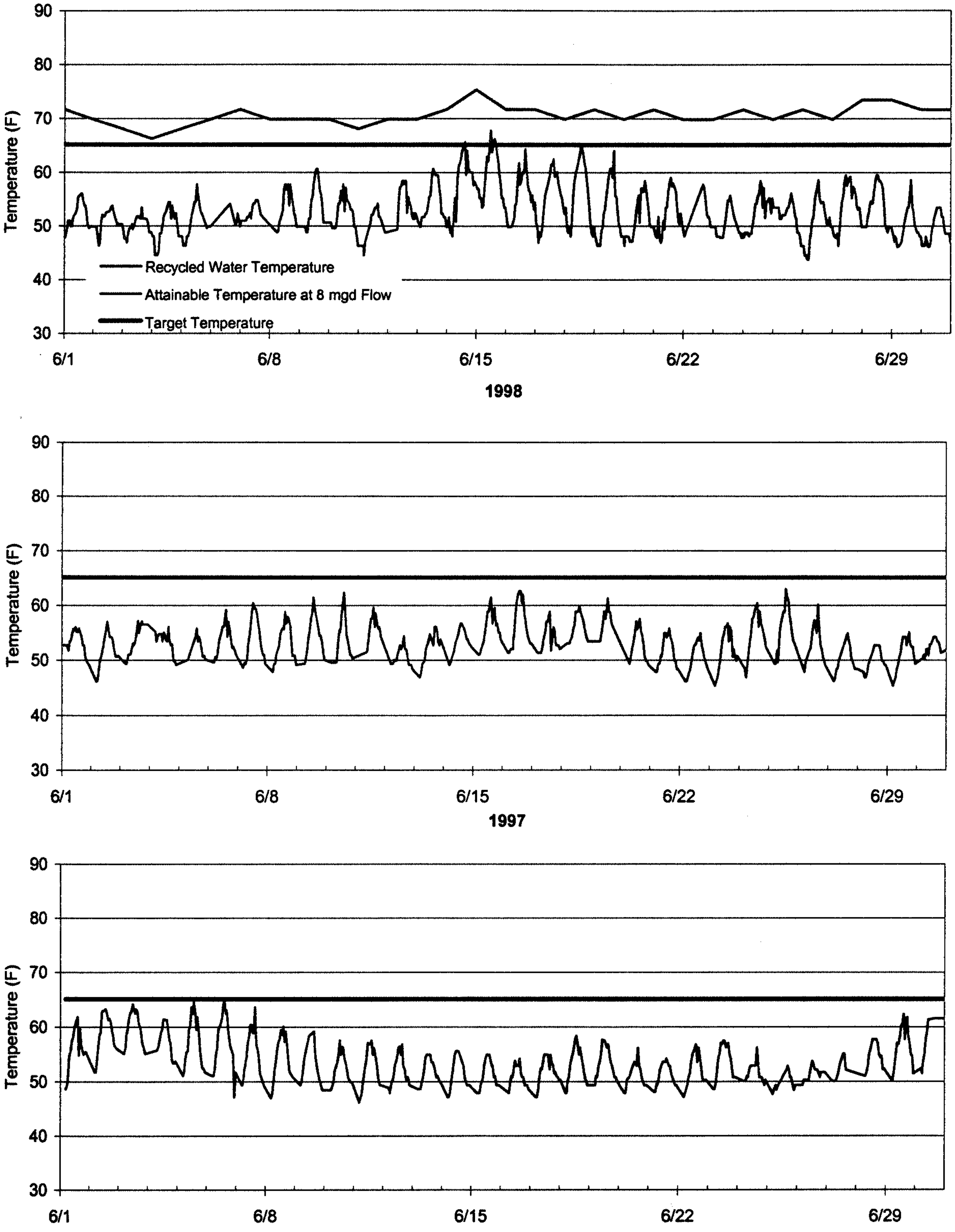


Figure A-4. Attainable Recycled Water Temperature for June Using a Chiller Capacity of 2,400 tons

July

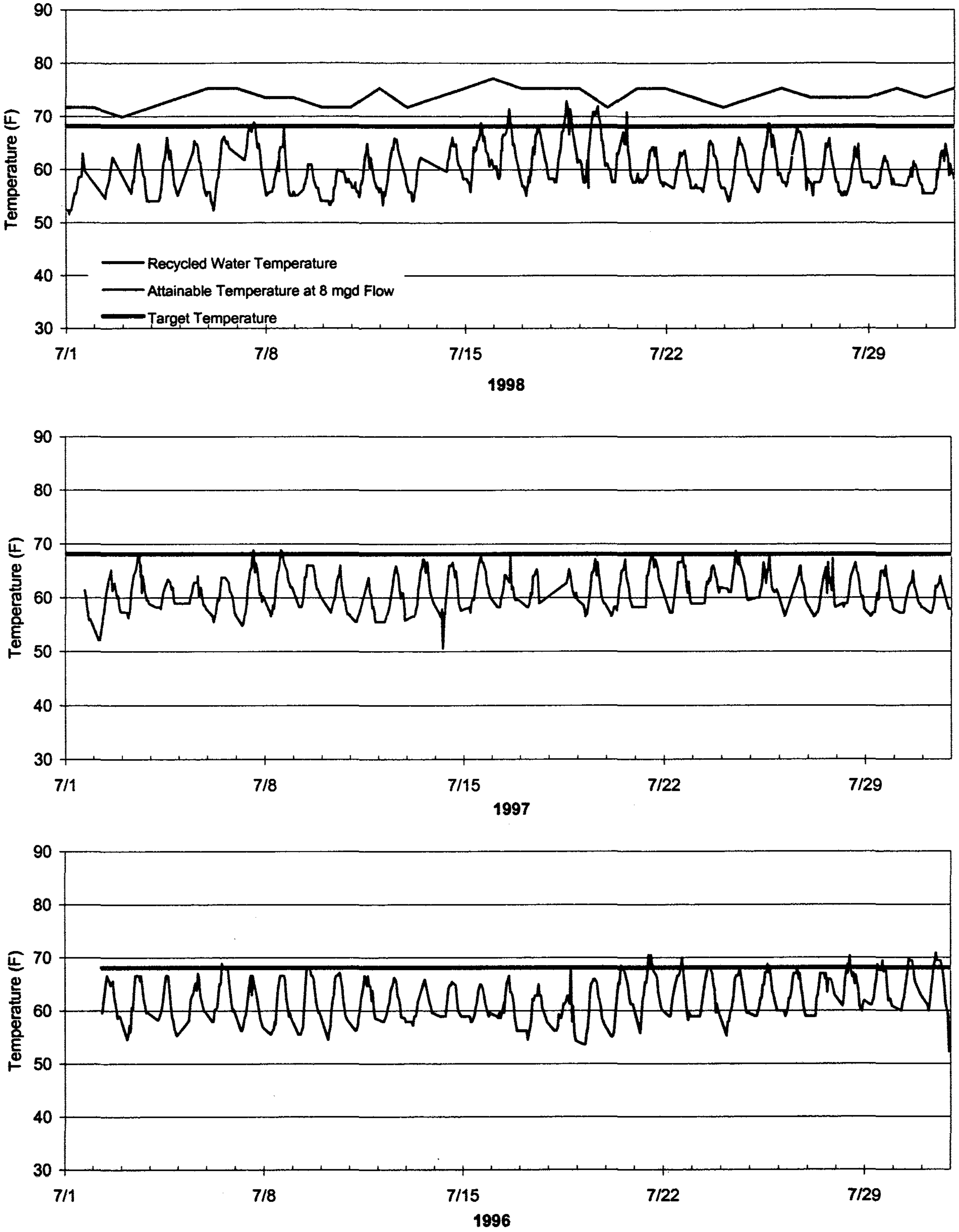


Figure A-5. Attainable Recycled Water Temperature for July Using a Chiller Capacity of 1,200 tons

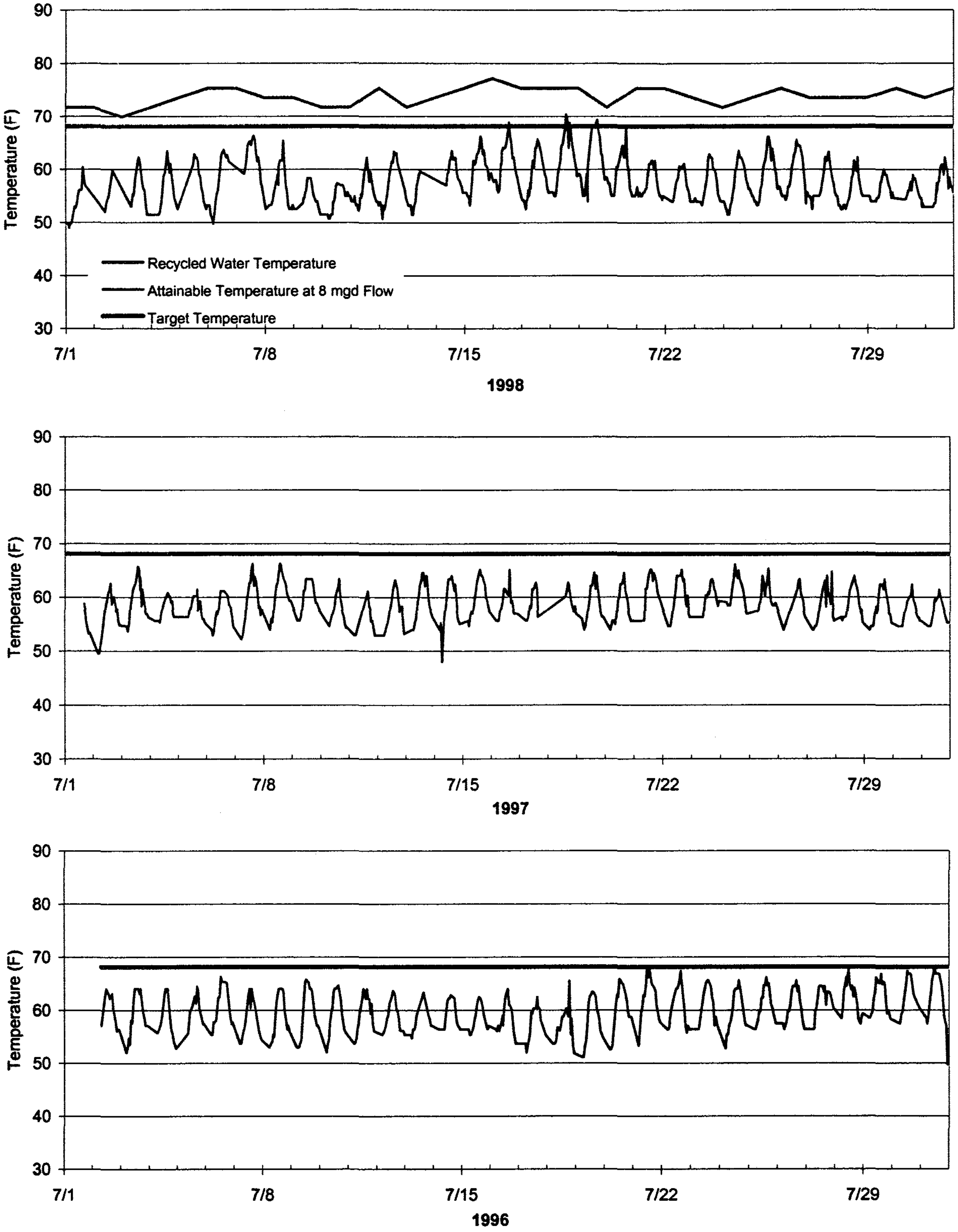


Figure A-6. Attainable Recycled Water Temperature for July Using a Chiller Capacity of 1,800 tons

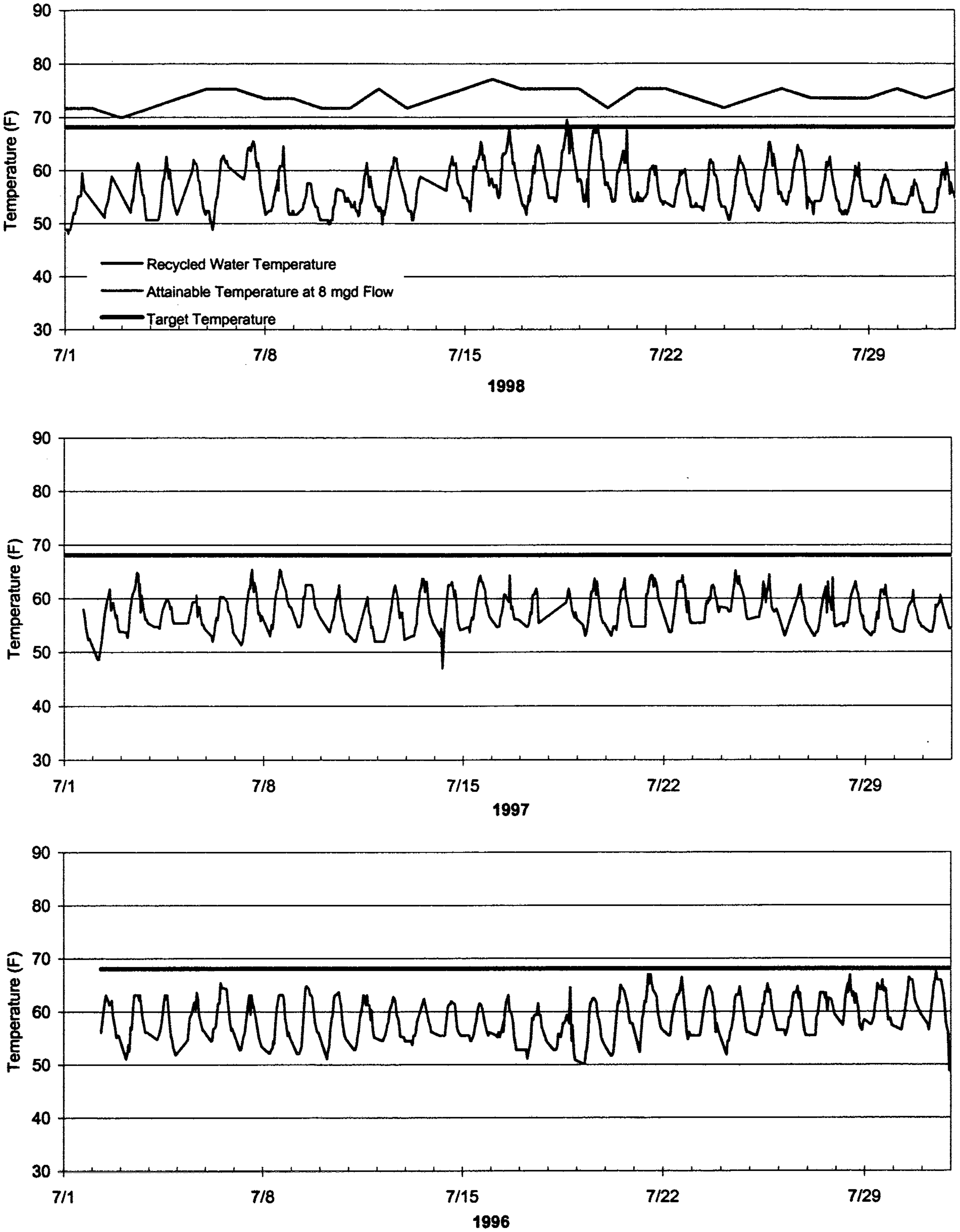


Figure A-7. Attainable Recycled Water Temperature for July Using a Chiller Capacity of 2,000 tons

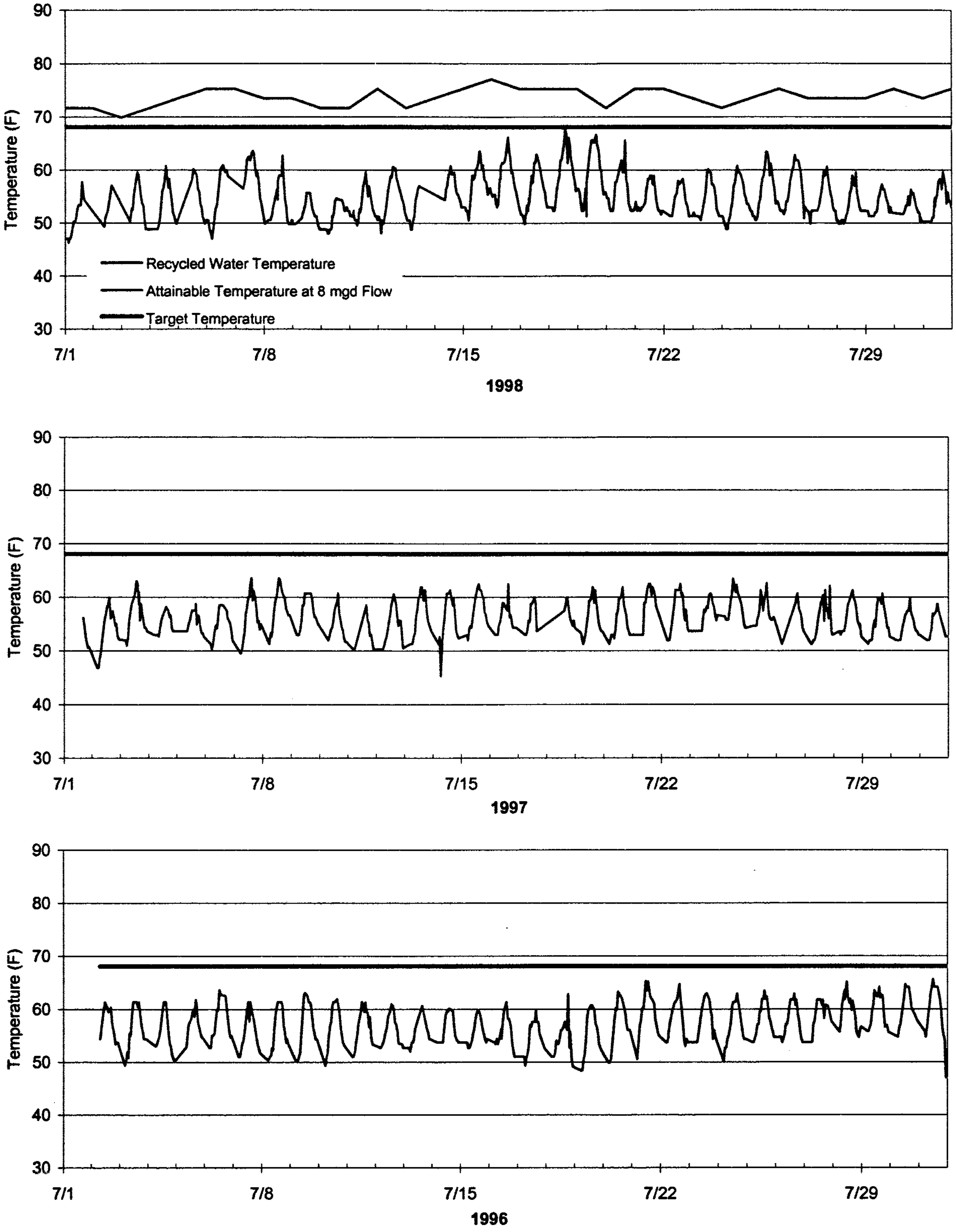


Figure A-8. Attainable Recycled Water Temperature for July Using a Chiller Capacity of 2,400 tons

August

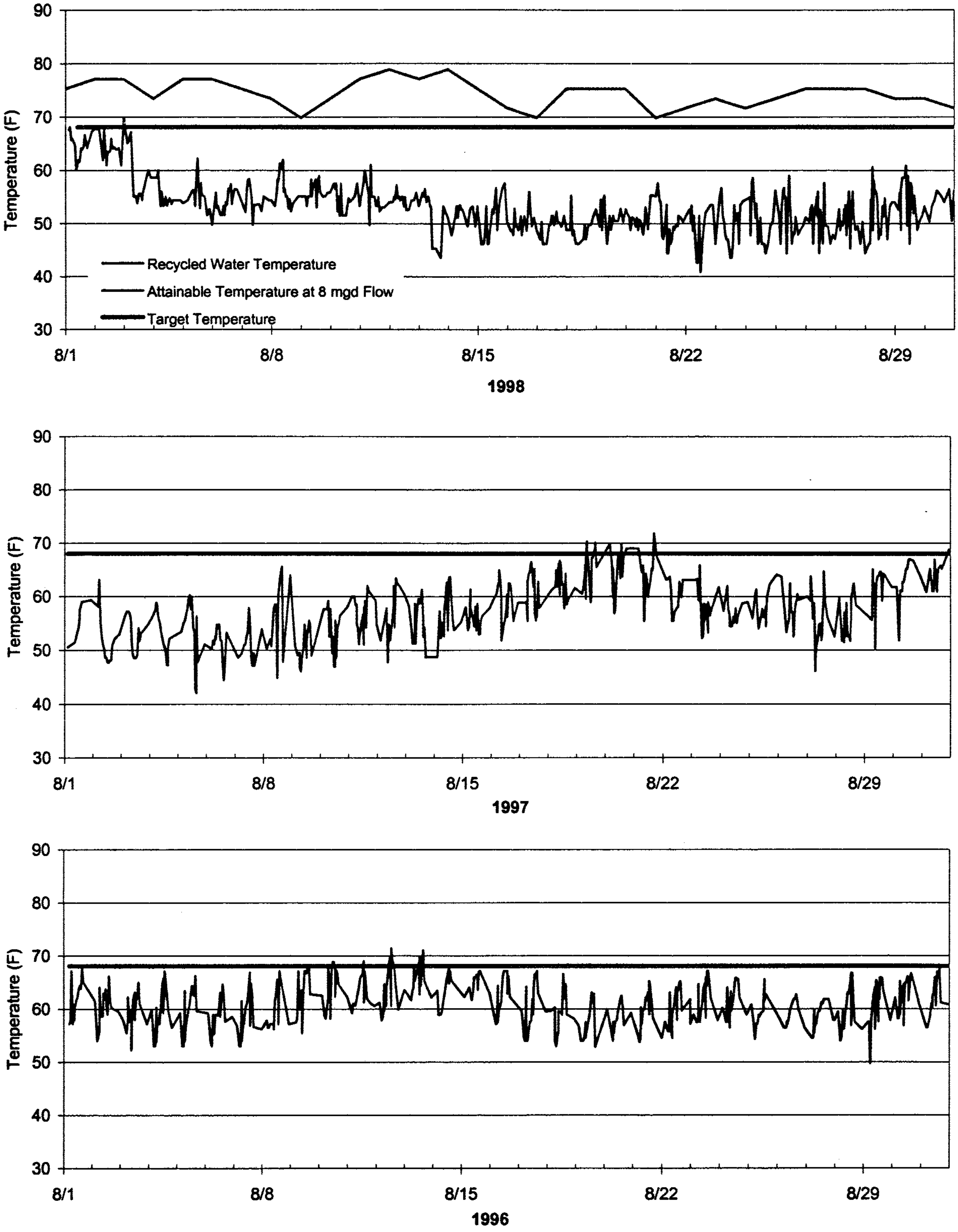


Figure A-9. Attainable Recycled Water Temperature for August Using a Chiller Capacity of 1,200 tons

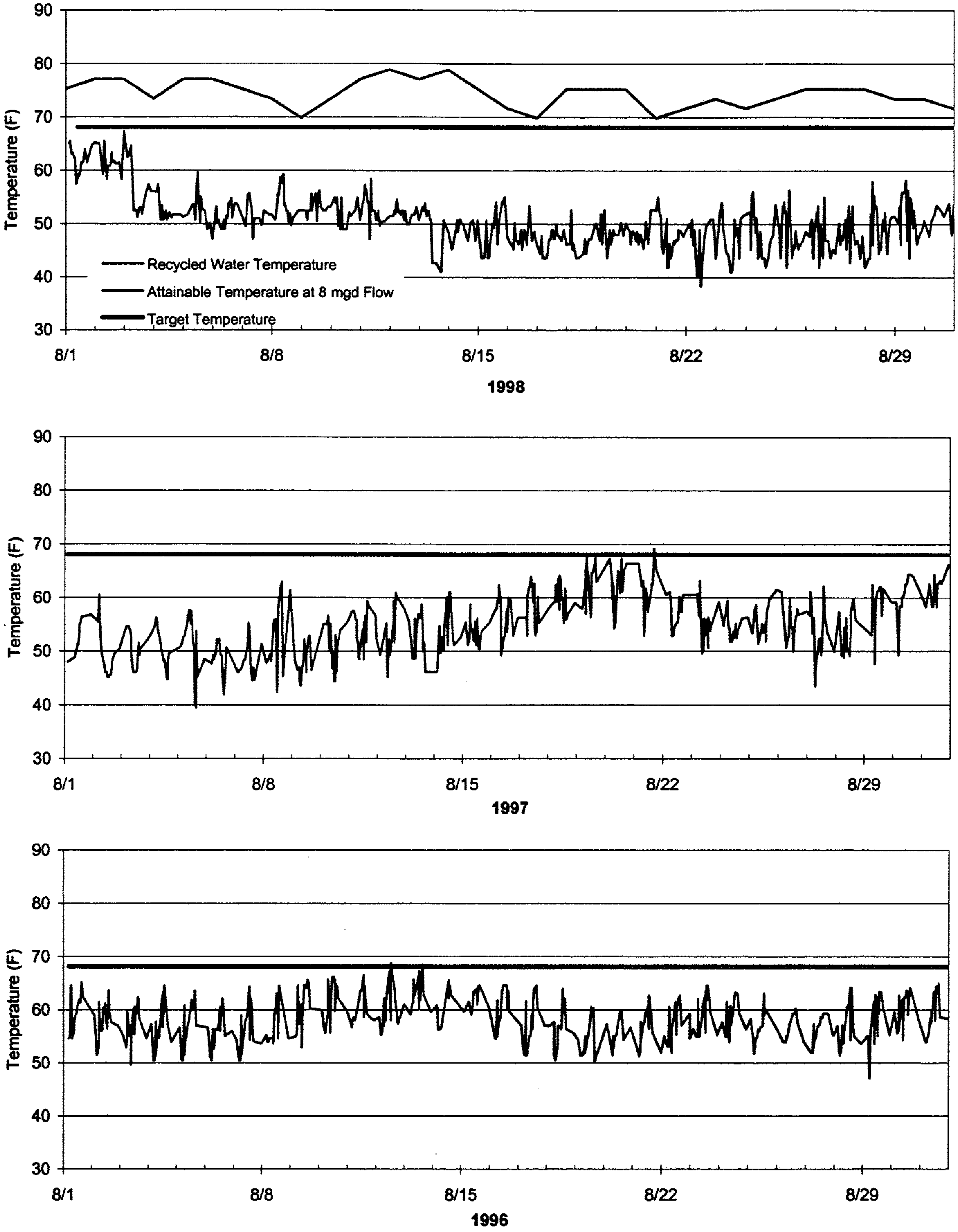


Figure A-10. Attainable Recycled Water Temperature for August Using a Chiller Capacity of 1,800 tons

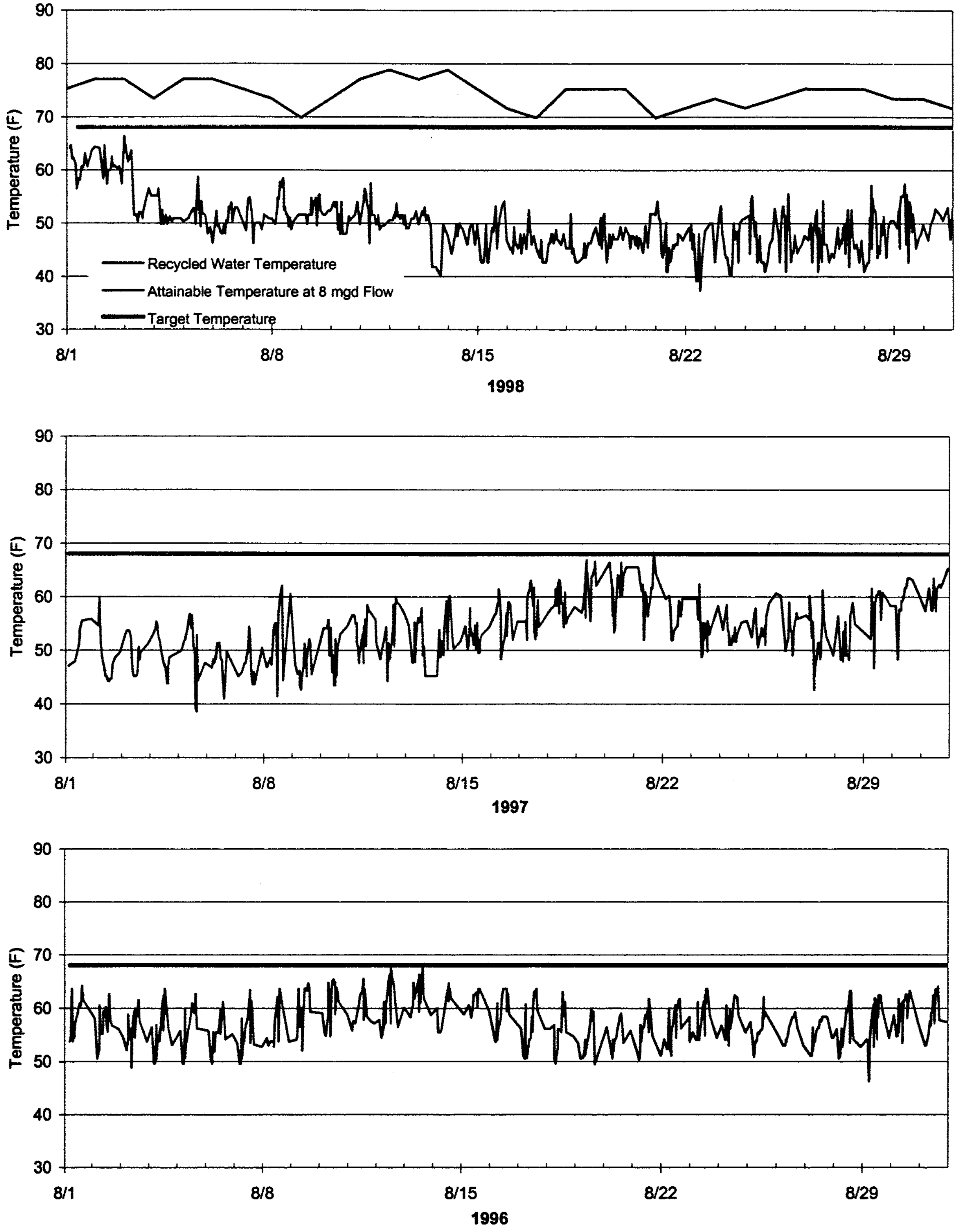


Figure A-11. Attainable Recycled Water Temperature for August Using a Chiller Capacity of 2,000 tons

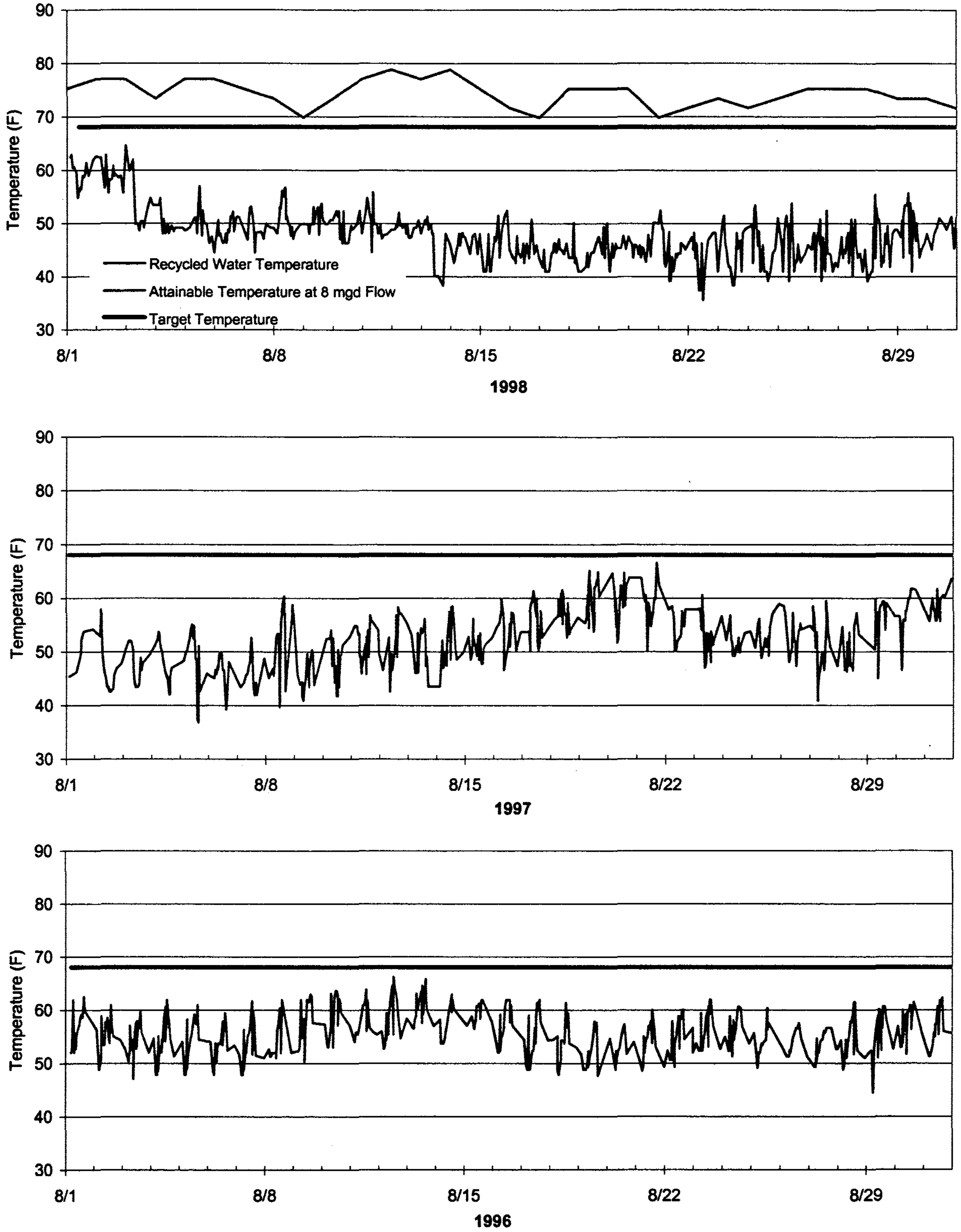


Figure A-12. Attainable Recycled Water Temperature for August Using a Chiller Capacity of 2,400 tons

September

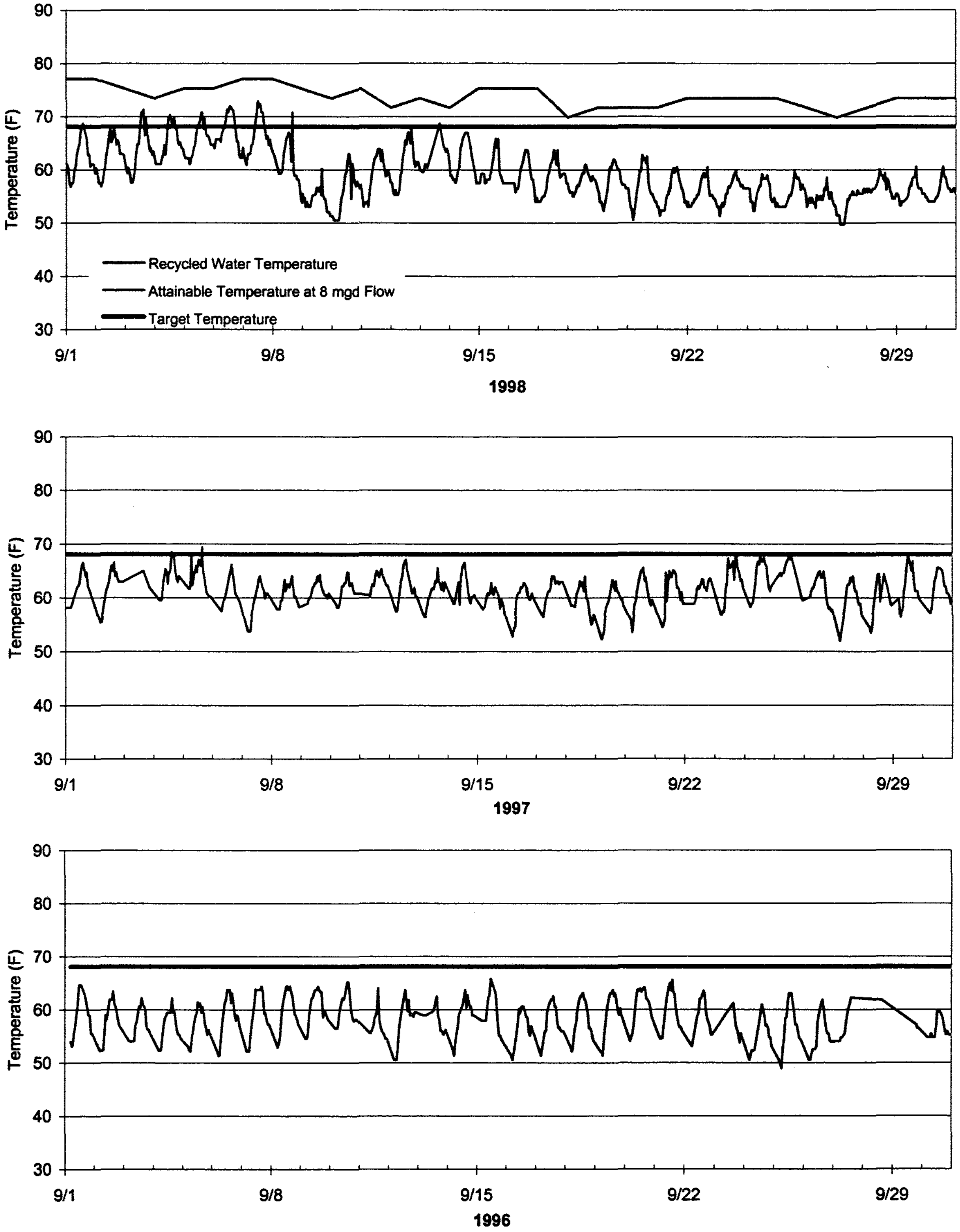


Figure A-13. Attainable Recycled Water Temperature for September Using a Chiller Capacity of 1,200 tons

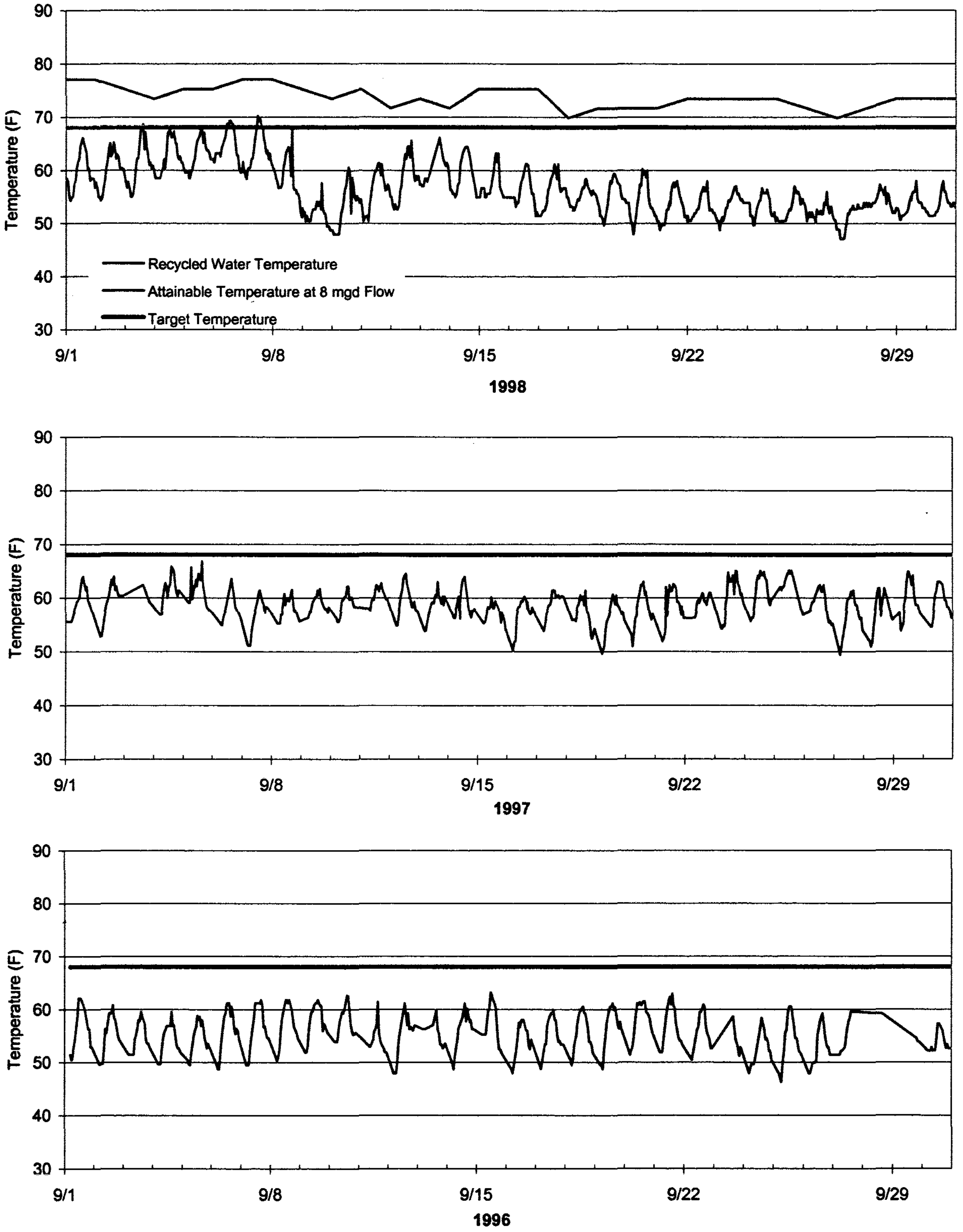


Figure A-14. Attainable Recycled Water Temperature for September Using a Chiller Capacity of 1,800 tons

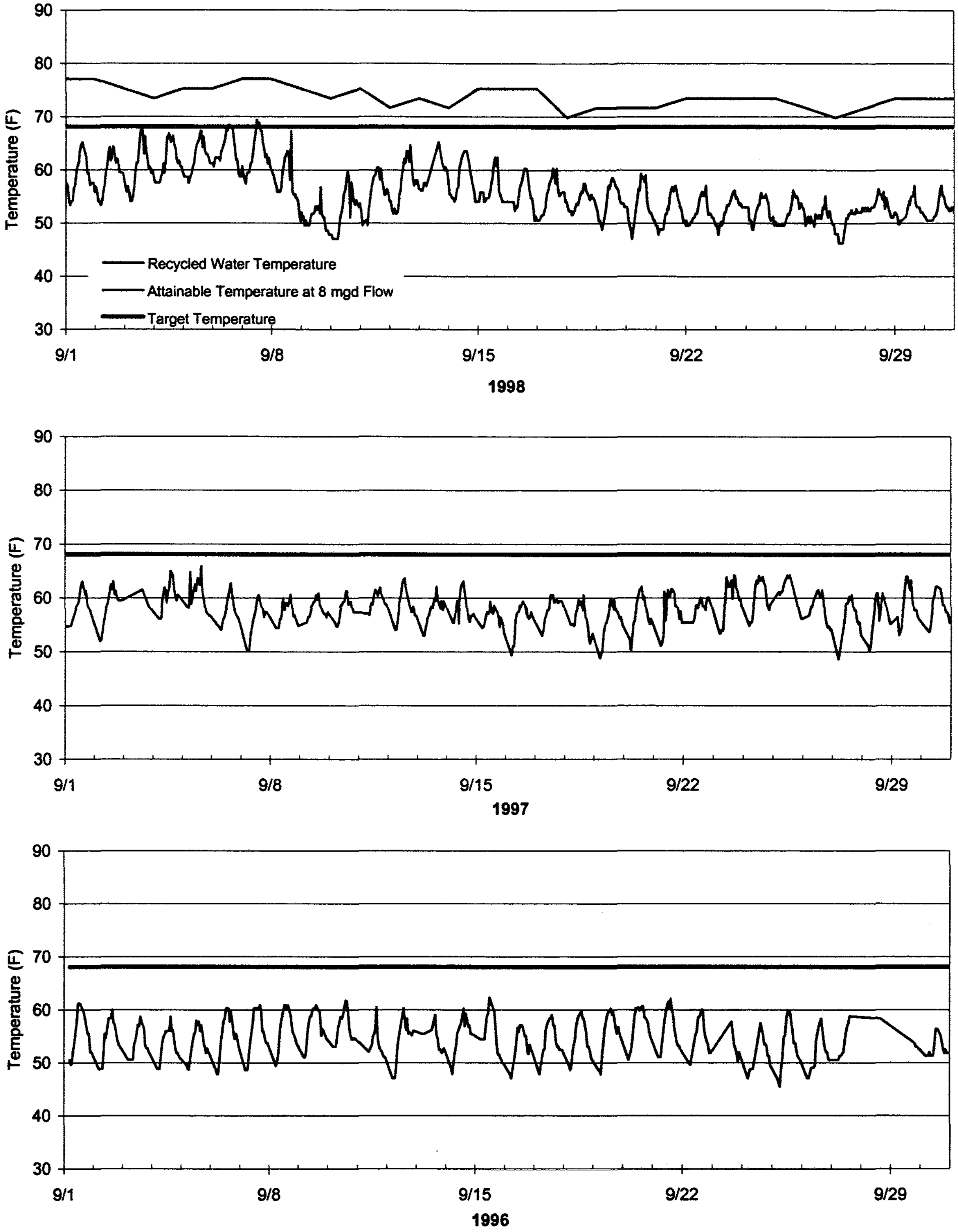


Figure A-15. Attainable Recycled Water Temperature for September Using a Chiller Capacity of 2,000 tons

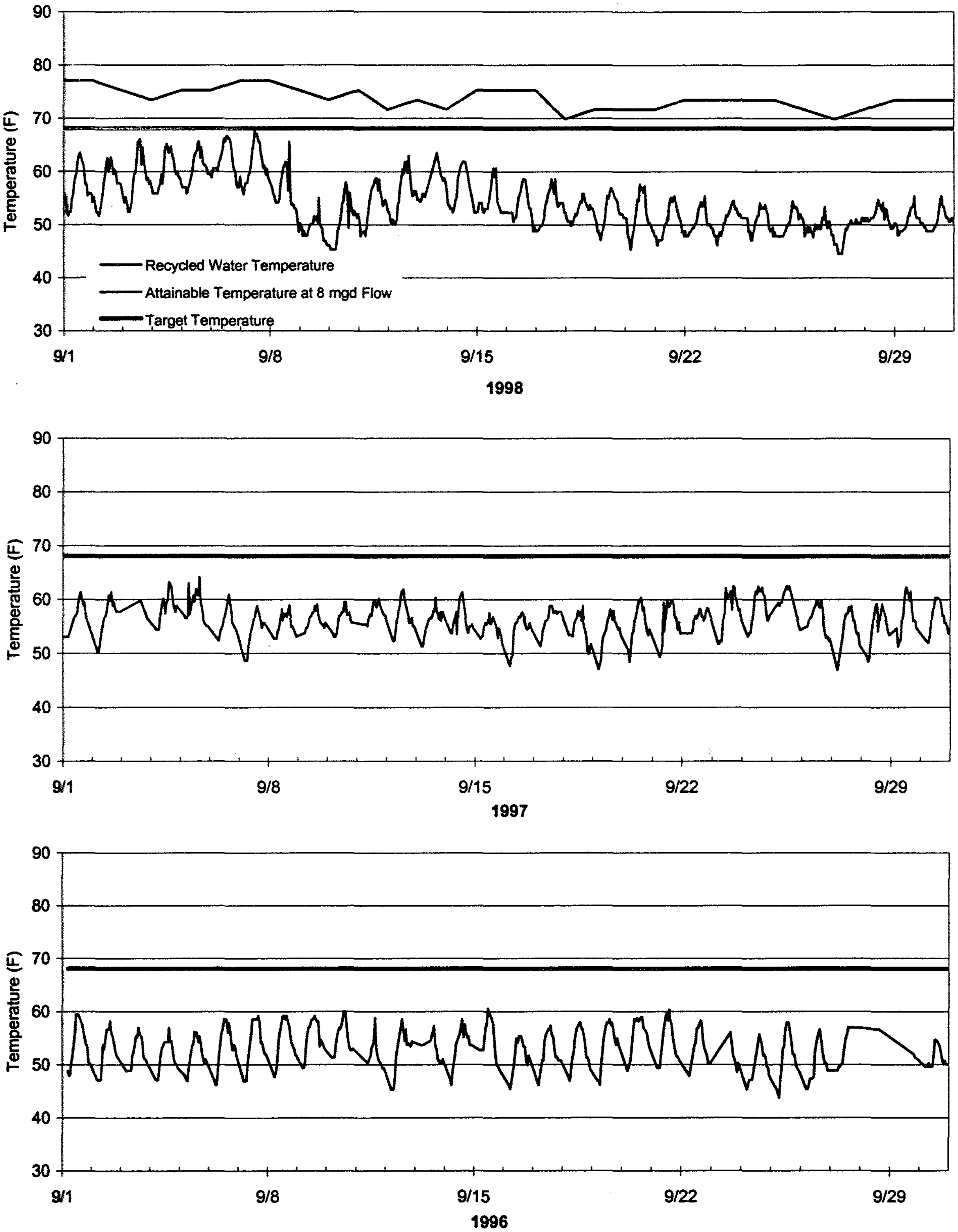


Figure A-16. Attainable Recycled Water Temperature for September Using a Chiller Capacity of 2,400 tons

October

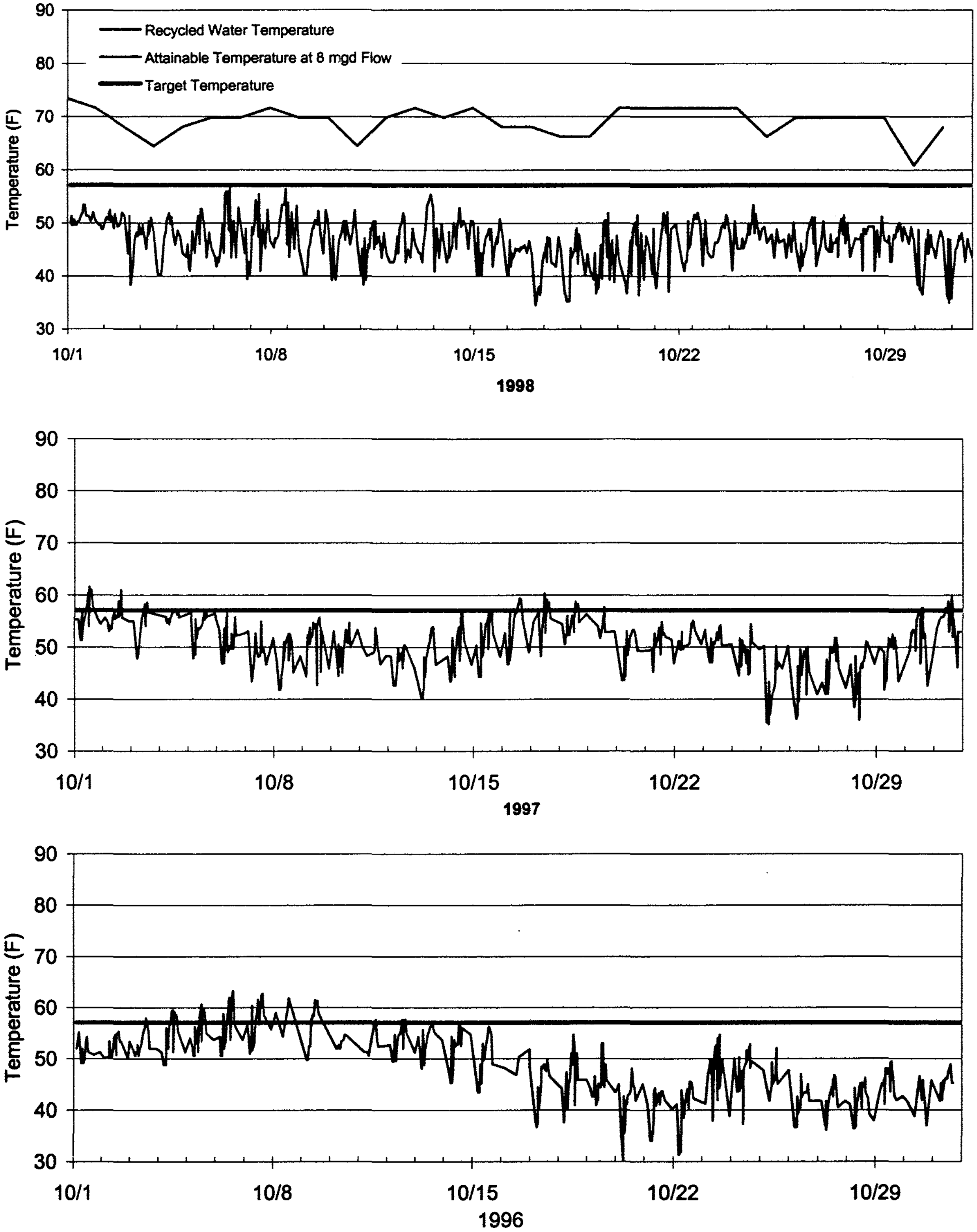


Figure A-17. Attainable Recycled Water Temperature for October Using a Chiller Capacity of 2,400 tons

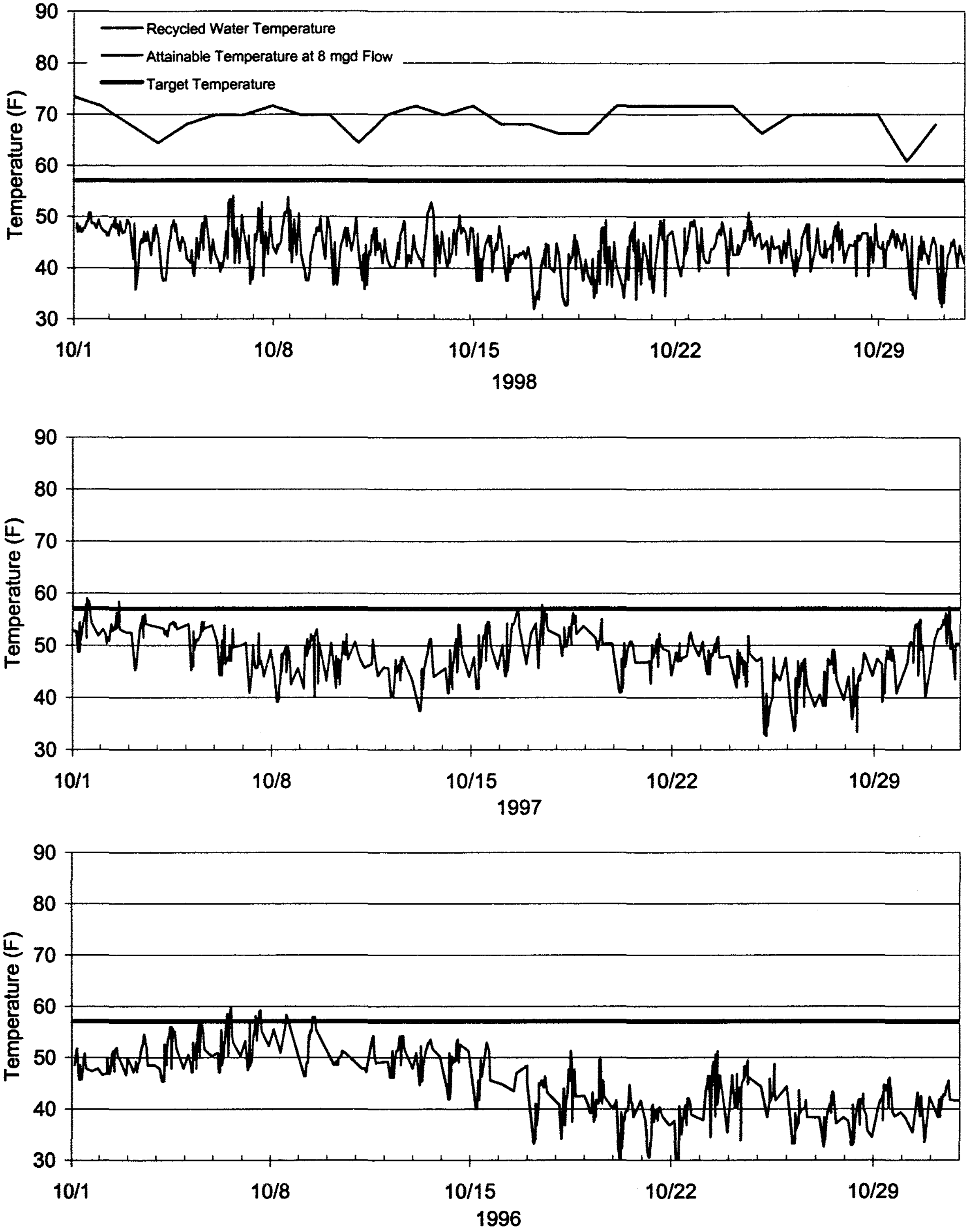


Figure A-18. Attainable Recycled Water Temperature for October Using a Chiller Capacity of 3,000 tons

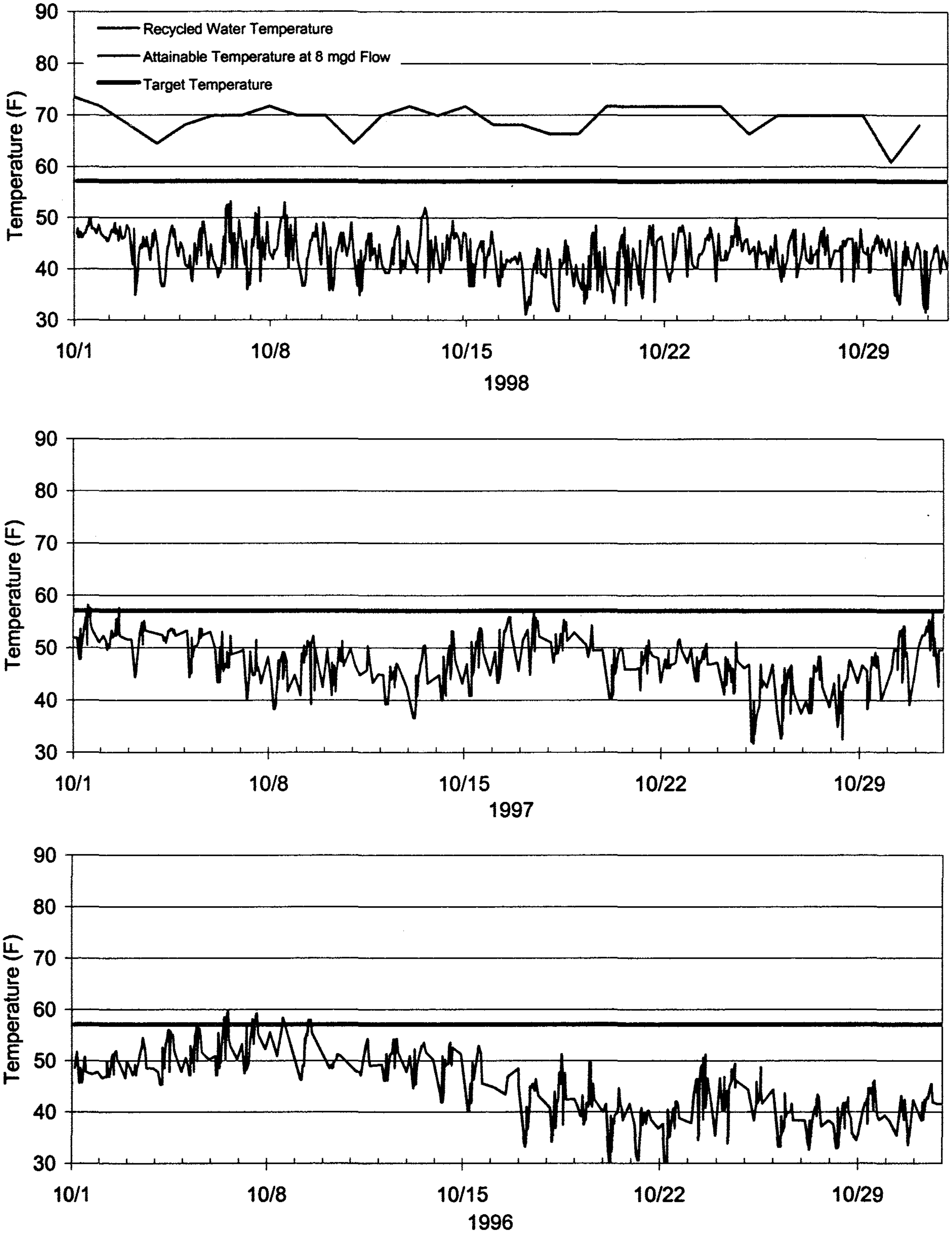
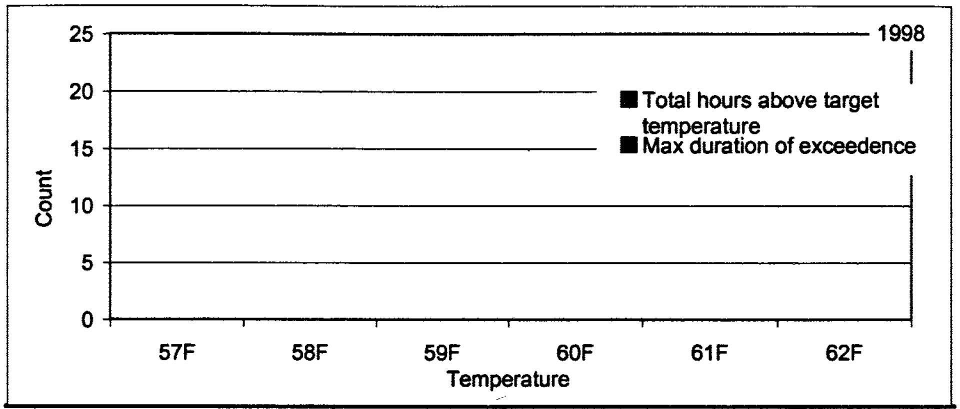
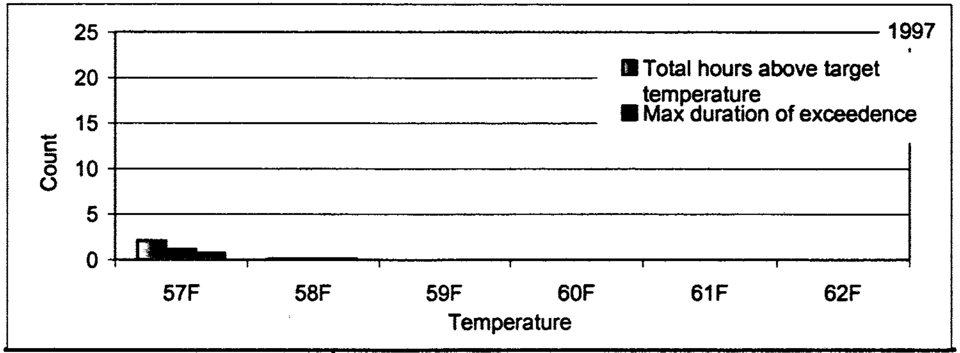


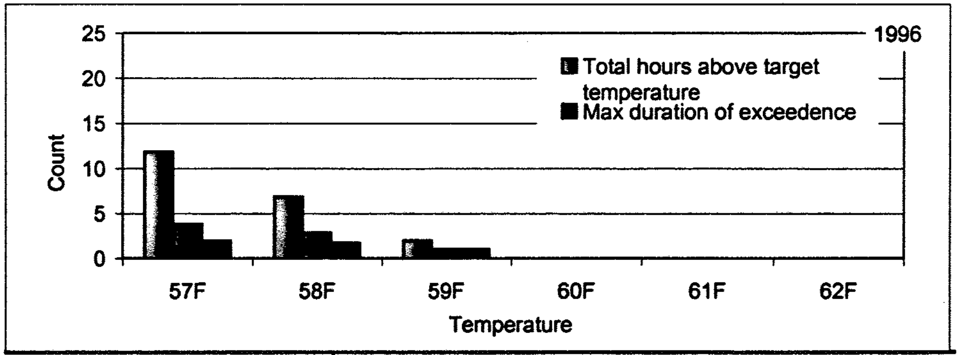
Figure A-19. Attainable Recycled Water Temperature for October Using a Chiller Capacity of 3,200 tons



October-98	Temperature 57F	58F	59F	60F	61F	62F
No. of occurrences	0	0	0	0	0	0
Total hours above target temperature	0	0	0	0	0	0
Max duration of exceedence	0	0	0	0	0	0
Average duration of exceedence	0	0	0	0	0	0



October-97	Temperature 57F	58F	59F	60F	61F	62F
No. of occurrences	3	1	0	0	0	0
Total hours above target temperature	2.1	0.1	0	0	0	0
Max duration of exceedence	1.2	0.1	0	0	0	0
Average duration of exceedence	0.8	0.1	0	0	0	0



October-96	Temperature 57F	58F	59F	60F	61F	62F
No. of occurrences	6	4	2	0	0	0
Total hours above target temperature	11.8	6.8	2.0	0	0	0
Max duration of exceedence	3.8	2.8	1.0	0	0	0
Average duration of exceedence	2.0	1.7	1.0	0	0	0

Figure A-20. Magnitude, frequency, and duration of chilled recycled water exceeding October temperature criteria for 3,200 ton chillers

DATE: December 11, 1998

TO: Don Arnold - City of San Jose
Tom Grieb - Tetra Tech
Chuck Hanson
Scott Cressey

FROM: Doug Brewer and Christopher Rogers

SUBJECT: Benthic Macroinvertebrate Survey on Coyote Creek

INTRODUCTION

In an effort to establish baseline habitat quality conditions before Coyote Creek streamflow augmentation in July 1999, quantitative benthic macroinvertebrate (BMI) samples were collected from 45 stations in Coyote Creek from the Coyote-Hellyer County Park (County Park) west of Cottonwood Lake every 0.5 mile to River Oaks Park (Appendix A). These preliminary samples will be used in conjunction with other predischarge samples collected in spring and summer 1999 to develop data that can be compared to postdischarge samples to determine any impacts, positive or negative, that may result from streamflow augmentation.

METHODS

A series of 45 BMI samples were collected by Scott Cressey, an independent fisheries biologist, between September 18 and October 3, 1998 using the California regional adaption of the U.S. Environmental Protection Agency Rapid Bioassessment Protocols (Plafkin et al. 1989). Jones & Stokes Associates received the samples on October 20, 1998. The sampling station coordinates were recorded using a Global Positioning System (GPS) unit. Samples were collected from three riffle transects per station. Three 1-minute kick samples were collected with a D-frame kick net at the two margins and the center of the stream. The three samples were combined into a single sample for each transect across the stream. Samples were taken from a 0.186-square-meter area within and downstream of the top of riffles. The samples were preserved immediately in 95% ethanol and labeled with the following information: collection number, station, date, and collector. The samples were transported to the Jones & Stokes Associates laboratory and placed in a locked cabinet.

Jones & Stokes Associates, Inc.
2600 V Street, Suite 100 • Sacramento, CA 95818-1914 • Fax 916/737-3030 • 916/737-3000

The contents of each sample were placed into a 300-micrometer sieve, gently rinsed, and then placed in a Pyrex™ pan with 30% ethanol. The sample contents were examined for BMI using illuminated magnifying glasses. All BMI were removed with forceps from the debris and placed in containers filled with 70% ethanol. A second technician reviewed each sample to ensure that all BMI were removed. If no further BMI were found, all debris were discarded. If the second technician found four or more BMI remaining in the sample, the original sorter would repeat the search of the entire sample.

Invertebrate biomass was estimated using volumetric displacement. BMI specimens from all samples were dried at room temperature on size-613 qualitative filter paper for 15 minutes and then placed in a 25-milliliter (-ml) graduated cylinder with 15 ml of 15°C deionized water. The volumetric displacement was determined and recorded.

The invertebrates were then placed in clear Pyrex™ trays, sorted, and enumerated. Specimens collected from each sample were identified to the lowest justifiable taxon using a Olympus SZ-ST40 zoom stereoscope and the appropriate taxonomic references (Arnett 1968, Bohart and Washino 1978, Edmunds et al. 1976, Gordon 1977, McAlpine et al. 1981, Merritt and Cummins 1984, Meyer and Durso 1993, Pennak 1978, Usinger 1956, Wiggins 1977) to establish diversity, taxa richness, and abundance and to develop community indices. Opportunistic species composition indices were not developed because of the lack of information about the ecological roles of many coastal-stream invertebrates.

All data were entered into a Lotus 123 spreadsheet (Table 1). Analytical summaries of the data are presented below and in Table 2 and Figures 1-4 at the end of this report.

RESULTS

Invertebrate Density

Invertebrate density is the number of individual invertebrates per cubic meter. The highest densities (as many as 888.02 individuals per square meter) were in samples from River Oaks Park, Williams Street Park (below the Yerba Buena Road bridge), and at the County Park downstream of Hellyer Avenue (Figure 1). The dominant organisms in the samples were freshwater clams (*Corbicula* sp.), making up as much as 95.6 % of samples, although blackflies (*Simulium* sp.) made up 46% of total density in the sample from Yerba Buena Road, mayflies (*Baetis* sp.) made up 63%

of total density in the sample from County Park above Yerba Buena Road, and turbellarian flatworms made up 47% of total density in the sample from County Park downstream of Hellyer Avenue.

The lowest densities were found in samples from upstream of the Montague Expressway, below Brokaw Road and between the golf course and Berryessa Road, with the lowest density being 23.32 individuals per square meter. The average density for all samples was 266.07 individuals per meter.

Taxa Richness

Taxa richness is the total number of individual taxa per sample and is used as a means by which to determine the overall health of an aquatic habitat (Plafkin et al. 1989). In general, the higher the water quality, habitat suitability, and variety, the higher the taxa richness. Taxa richness was highest in samples below the Yerba Buena Road bridge (Figure 2), with as many as 34.09 taxa per square meter. Samples from between State Route 280 and Story Road had the lowest taxa richness with only 5.38 taxa per square meter. The average taxa richness for all samples was 17.26 taxa per square meter.

Benthic Macroinvertebrate Productivity

BMI productivity is defined as the grams of living invertebrates per cubic meter within the study area. Samples from below Brokaw Road (Figure 3) demonstrated the highest productivity, of up to 8.52 grams of invertebrate per square meter. (A sample from below Brokaw Road had a productivity of 16.59 grams of invertebrate per square meter; however, 9 grams were from a single, oversized *Corbicula* sp. shell.)

Samples from upstream of the Montague Expressway Bridge demonstrated the lowest productivity of as little as 0.45 gram of invertebrate per square meter. The average productivity for all samples was 1.97 grams of invertebrate per square meter.

EPT Index

Relative habitat health can be examined by measuring the abundance of invertebrate families most sensitive to changes in water quality and habitat. The EPT (Ephemeroptera, Plecoptera, Trichoptera) index examines nymphal Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflles). As a group, these invertebrates are generally considered to be pollution sensitive and their abundance index increases with increasing water quality (Plafkin et al. 1989). The ratio of EPT to all other taxa was used as a gauge of habitat health (Figure 4). Plecopterans were not present in any of the samples.

Only 34 of the 45 samples contained mayflies or caddisflies and, of these, only two species of mayfly and two species of caddisfly were represented. This may be because of the seasonality of these invertebrate species; greater diversity and abundance would be expected in spring and summer samples. The highest EPT indices, 2.13 and 1.22, were observed in samples from County Park above Yerba Buena Road and Stone Gate Park, respectively. The average EPT index for all samples was 0.36. The overall paucity of EPT taxa may indicate that this creek system is of low-quality habitat.

CONCLUSIONS

The data yielded from this sampling effort characterize Coyote Creek at a single point in time. Additional samples, data, and analyses are necessary to adequately describe the system; however, the data calculated from current samples describe a ecologically disturbed system, with little or no uniformity between sampling stations.

Density, taxa richness, productivity, and EPT ratios indicate a stream that is dominated by ecologically tolerant species. The greatest densities and productivity appear at the extreme downstream end and at the upper one-third of our study area. The greatest taxa richness and sensitive-species ratios also appear limited to the upper one-third of the study area. The community structure data should make future comparisons fairly simple because of the low numbers of taxa.

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Table 1. **Coyote Creek Invertebrates**
Collected IX-18-98 through X-3-98

Phylum	Class	Order	Family	Sub Family	Genus	Specific Epithet	TR2-3B-1	TR2-3B-2	TR2-3B-3	TR2-2B-1	TR2-2B-2	TR2-2B-3	TR2-1B-1	TR2-1B-2	TR2-1B-3	TR2-5B-1	TR2-5B-2	TR2-5B-3	TR2-4B-1	TR2-4B-2	TR2-4B-3
Turbellaria																	1		1	1	1
Nematoda													1								
Annelida	Oligochaeta		Lumbriculidae				8	5	3	2	4	6		2	1	1		1		4	4
	Hirudina				follows Haemopsis												1	1			
	Polychaeta		Nereidae		Neanthes	limnicola			1	2	1	1	5	2	4						
Arthropoda	Arachnida	Hydracarina																1			
	Crustacea	Amphipoda	Gammaridae		Gammarus			6	2	1			1	2	14	8	4	3		3	2
					Corophium	spinocorne															
		Decapoda	Pascifasticidae		Pascifasticus	lenniscululus									1	3	1				
	Insecta	Ephemeropte	Baetidae		Baetis		1									3	6	5	1		
			Tricorythidae		Tricorythodes	fallax															
		Odonata	Zygoptera		Argia		1						1			12	9	9	1		
					Hetaerina																
		Megaloptera			Sialis		1														
		Coleoptera	Dryopidae		Helichus		1													1	
			Elmidae		Zaitevia		1														
					Optiocervis		10	8	14	1					5				18	24	9
			Hydrophilidae		Paracymus																
		Diptera	Simuliidae		Simulium			3						1	1	2	12	1	2	1	
					pupae						1				1			1			
			Tipulidae		Limonia																
			Cerratopogonidae		Bezzia																
			Chironmidae		pupae					3		6	3			1			2		
				Orthocladinae						7	2	11	4		4	2	2	3	1		
				Chironominae							1	1				4	6	3			
				Tanypodinae																	
			Ephydrydae																		
			Empididae																1		
					pupae																
			Phoridae																		
			Stratiomyidae		Nemotalus																
		Trichoptera	Hydroptilidae		Hydroptila							1			1		7	8	1	1	
					pupae																
			Hydropsychidae		Hydropsyche														4	1	
					pupae																
		Hemiptera	Corixidae																		
		Lepidoptera			Petrophila																
Mollusca	Gastropoda		Planorbidae		Gyraulus																
			Physidae		Physatella		1		1						1	1	1	1			
			Lymnaeidae															1			
			Ancylidae		Ferrissa											4	23	7	1	1	
					Parapholyx																
	Bivalvia		Corbiculidae		Corbicula		14	12	24	10	4	7	1422	495	756	3	60	25	1		1
		TOTAL					38	34	45	26	13	33	1437	502	789	44	133	70	34	37	17

Table 1. **Coyote Creek Invertebrates**
[Continued] Collected IX-18-98 through X-3-98

Phylum	Class	Order	Family	Sub Family	Genus	Specific Epithet	TR1-4B-1	TR1-4B-2	TR1-4B-3	TR1-3B-1	TR1-3B-2	TR1-3B-3	TR1-2B-1	TR1-2B-2	TR1-2B-3	TR1-1B-1	TR1-1B-2	TR1-1B-3
Turbellaria											2					1		
Nematoda																		
Annelida	Oligochaeta		Lumbriculidae				8	6	1	7	2		2	5	4	17	2	4
	Hirudina				follows Haemopsis										1			
	Polychaeta		Nereidae		Neanthes	limnicola												
Arthropoda	Arachnida	Hydracarina																
	Crustacea	Amphipoda	Gammaridae		Gammarus		22	18	16					6	2	4	17	10
					Corophium	spinocorne	1								1			
		Decapoda	Pascifasticidae		Pascifasticus	lennisculus	6	3	3						2		3	
	Insecta	Ephemeroptera	Baetidae		Baetis			1	2	1						3		
			Tricorythidae		Tricorythodes	fallax	20	11	13									
		Odonata	Zygoptera		Argia													
					Hetaerina													
		Megaloptera			Sialis													
		Coleoptera	Dryopidae		Helichus													
			Elmidae		Zaitevia													
					Optiocervis													
			Hydrophilidae		Paracymus													
		Diptera	Simuliidae		Simulium						5	1						
					pupae													
			Tipulidae		Limonia													
			Cerratopogonidae		Bezzia				1									
			Chironmidae		pupae				1					1				
				Orthocladinae			1	2	2	2	1	2	1	3	3	1		
				Chironominae					7					1				
				Tanypodinae														
			Ephydrydae															
			Empididae															
					pupae													
			Phoridae															
			Stratiomyidae		Nemotalus													
		Trichoptera	Hydroptilidae		Hydroptila							2				2	2	3
					pupae													
			Hydropsychidae		Hydropsyche						1	1						
					pupae													
		Hemiptera	Corixidae															
		Lepidoptera			Petrophila													
Mollusca	Gastropoda		Planorbidae		Gyraulus													
			Physidae		Physatella					1				4		1		
			Lymnaeidae												1		1	
			Ancylidae		Ferrissa		2					2					13	8
					Parapholyx													
	Bivalvia		Corbiculidaae		Corbicula					2			17	71	23	43	24	91
		TOTAL					60	41	46	13	11	8	20	91	37	72	62	116

Table 1. **Coyote Creek Invertebrates**
[Continued] Collected IX-18-98 through X-3-98

Phylum	Class	Order	Family	Sub Family	Genus	Specific Epithet	CR1-B1	CR1-B2	CR1-B3	TR1-5-B1	TR1-5B-2	TR1-5B-3	CR-3B-1	CR-3B-2	CR-3B-3	CR-2B-1	CR-2B-2	CR-2B-3	CR-5B-1	CR-5B-2	CR-5B-3	CR-4B-1	CR4-B-2	CR-4B-3
Turbellaria								1		5	3	3	23	10	15	3	4		5		1	232	62	98
Nematoda																								
Annelida	Oligochaeta		Lumbriculidae				1	5		2		1		1		5	2	3	10	11	3	1	4	3
	Hirudina				follows Haemopsis																			1
	Polychaeta		Nereidae		Neanthes	limnicola																		
Arthropoda	Arachnida	Hydracarina																						
	Crustacea	Amphipoda	Gammaridae		Gammarus				1	2			7	12	13	5	5	11	8	1	3			
					Corophium	spinocome	15		27	3		2		5		11	3	4	4	1	39		2	1
		Decapoda	Pascifasticidae		Pascifasticus	lennisculus			3				1			2			1					
	Insecta	Ephemeroptera	Baetidae		Baetis		11	48	3	53	52	20	17	139	26	35	53	68	7	12	11	15	28	14
			Tricorythidae		Tricorythodes	fallax	1		1	14	2	19		1		3		7		1	2			
		Odonata	Zygoptera		Argia		2	10		1		1	42	20	24	3	3	5	5			8	14	9
					Hetaerina																			1
		Megaloptera			Sialis				1	3	2							1	3		5			
		Coleoptera	Dryopidae		Helichus											1	1							
			Elmidae		Zaitevia																			
					Optiocervis						1	1	5		6		1	1				9	14	6
			Hydrophilidae		Paracymus					1	1													
		Diptera	Simuliidae		Simulium			14				1	23	17	8	9	24	151				9	20	11
					pupae		1	10					10		3	2	1	4				3	4	2
			Tipulidae		Limonia												1							
			Cerratopogonidae		Bezzia																			
			Chironmidae		pupae		1	2		26	7	17		1	1	1		4			2			
				Orthocladinae				5	1	42	22	33	11	3	3	2	2	22		3	3	1		1
				Chironominae				1		7	10	12						1						
				Tanypodinae																	1			
			Ephydrydae					1																
			Empididae													3	1							
					pupae											1	1	1						1
			Phoridae									1												
			Stratiomyidae		Nemotalus															1				
		Trichoptera	Hydroptilidae		Hydroptila										2		1	1			1			
					pupae																		2	
			Hydropsychidae		Hydropsyche			8		1	2	1	7	9	4	7	8	27	3	6		82	144	109
					pupae																			1
		Hemiptera	Corixidae				1	1	1	6		2												
		Lepidoptera			Petrophila															1				
Mollusca	Gastropoda		Planorbidae		Gyraulus			1														1		
			Physidae		Physatella									1			1						2	
			Lymnaeidae						2	1														
			Ancylidae		Ferrissa																1			
					Parapholyx													2						
	Bivalvia		Corbiculidaae		Corbicula		2	1	4				3		3	2	3	14				134	34	24
		TOTAL					35	108	44	167	102	114	149	219	108	95	115	327	46	37	72	495	330	282

Table 2.

Coyote Creek Initial Sampling, September 1998

Per Square Meter

River Mile	Sampling Station	Code	Productivity	Density	Taxa Richness	EPT
5.1	River Oaks Park	TR2-1B-1	0.90	2577.96	12.56	0.00
		TR2-1B-2	0.90	900.58	8.97	0.00
		TR2-1B-3	0.90	1415.45	19.73	0.00
5.6	Montague Expressway Bridge	TR2-2B-1	0.45	46.64	12.56	0.00
		TR2-2B-2	0.45	23.32	10.76	0.00
		TR2-2B-3	0.45	59.20	12.56	0.03
6.6	Below Brokaw Road	TR2-3B-1	16.59	68.17	16.15	0.03
		TR2-3B-2	4.48	61.00	8.97	0.00
		TR2-3B-3	8.52	80.73	10.76	0.00
8.1	Between the Golf Course and Berryessa Bridge	TR2-4B-1	3.14	61.00	21.53	0.21
		TR2-4B-2	1.35	66.38	16.15	0.06
		TR2-4B-3	0.90	30.50	8.97	0.00
9.1	Above Mabury Road near the City Corp Yard	TR2-5B-1	0.90	78.94	21.53	0.07
		TR2-5B-2	0.90	238.60	23.32	0.11
		TR2-5B-3	0.45	125.58	26.91	0.23
11.1	Williams Street Park	TR1-1B-1	0.90	129.17	14.35	0.07
		TR1-1B-2	0.45	111.23	12.56	0.03
		TR1-1B-3	0.90	208.10	8.97	0.03
11.7	Between RTE 280 and Story Road	TR1-2B-1	0.90	35.88	5.38	0.00
		TR1-2B-2	0.45	163.25	12.56	0.00
		TR1-2B-3	0.45	66.38	14.35	0.00
12.3	Lower Kelley Park	TR1-3B-1	0.45	23.32	8.97	0.08
		TR1-3B-2	2.69	19.73	8.97	0.10
		TR1-3B-3	0.90	14.35	8.97	0.60
13.1	Upper Kelley Park	TR1-4B-1	1.35	107.64	12.56	0.50
		TR1-4B-2	2.24	73.55	10.76	0.41
		TR1-4B-3	0.90	82.52	16.15	0.48
14.7	Stone Gate Park	TR1-5B-1	0.45	299.60	26.91	0.69
		TR1-5B-2	1.35	182.99	17.94	1.22
		TR1-5B-3	0.45	204.51	25.12	0.54
15.2	Horseshoe Club, above Umbarger Road	CR-1B-1	1.35	62.79	16.15	0.52
		CR-1B-2	0.90	193.75	25.12	1.08
		CR-1B-3	0.90	78.94	17.94	0.10
16.5	Below Yerba Buena Road	CR-2B-1	2.69	170.43	30.50	0.90
		CR-2B-2	1.79	206.31	32.29	1.17
		CR-2B-3	1.35	586.63	34.09	0.46
16.7	County Park above Yerba Buena Road	CR-3B-1	3.14	267.30	19.73	0.19
		CR-3B-2	1.35	392.88	21.53	2.13
		CR-3B-3	2.69	193.75	21.53	0.42
17.3	County Park downstream of Hellyer Avenue	CR-4B-1	0.90	888.02	19.73	0.24
		CR-4B-2	0.90	592.02	21.53	1.12
		CR-4B-3	0.90	505.90	26.91	0.78
17.8	County Park west of Cottonwood Lake	CR-5B-1	4.04	82.52	16.15	0.28
		CR-5B-2	5.38	66.38	16.15	1.06
		CR-5B-3	4.48	129.17	21.53	0.24
		AVERAGE	1.97	266.07	17.26	0.36

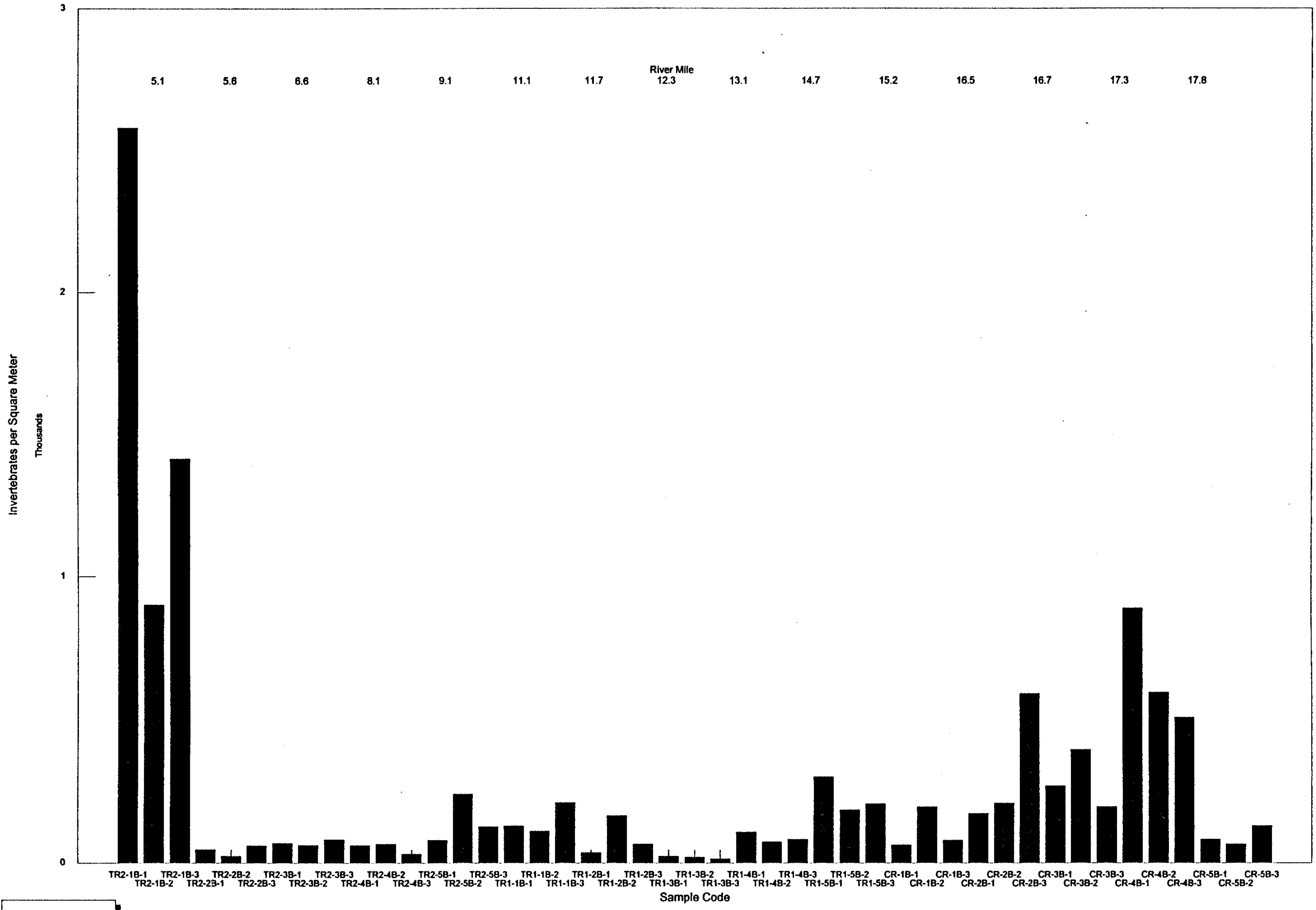


Figure 1.
Invertebrate Density

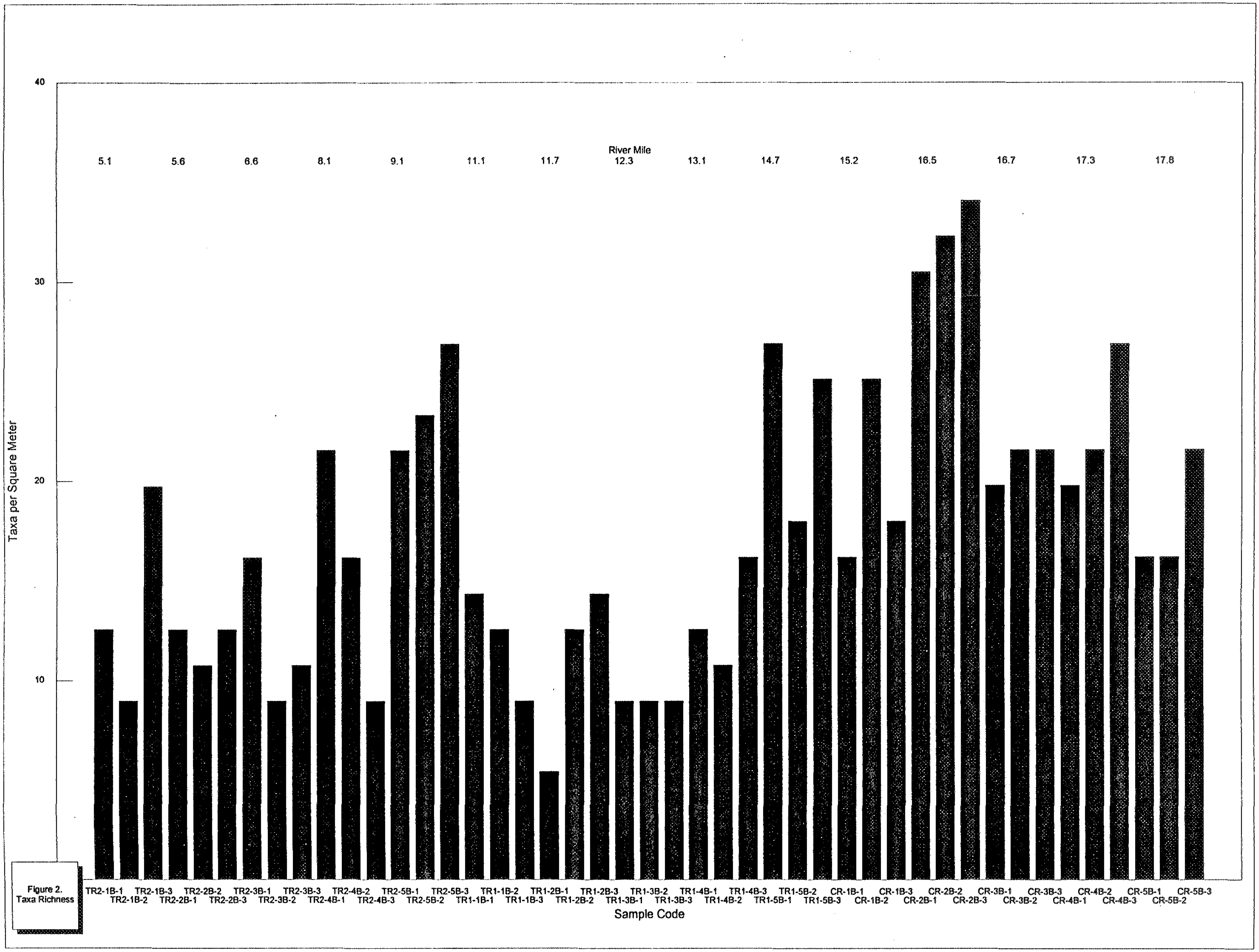


Figure 2.
Taxa Richness

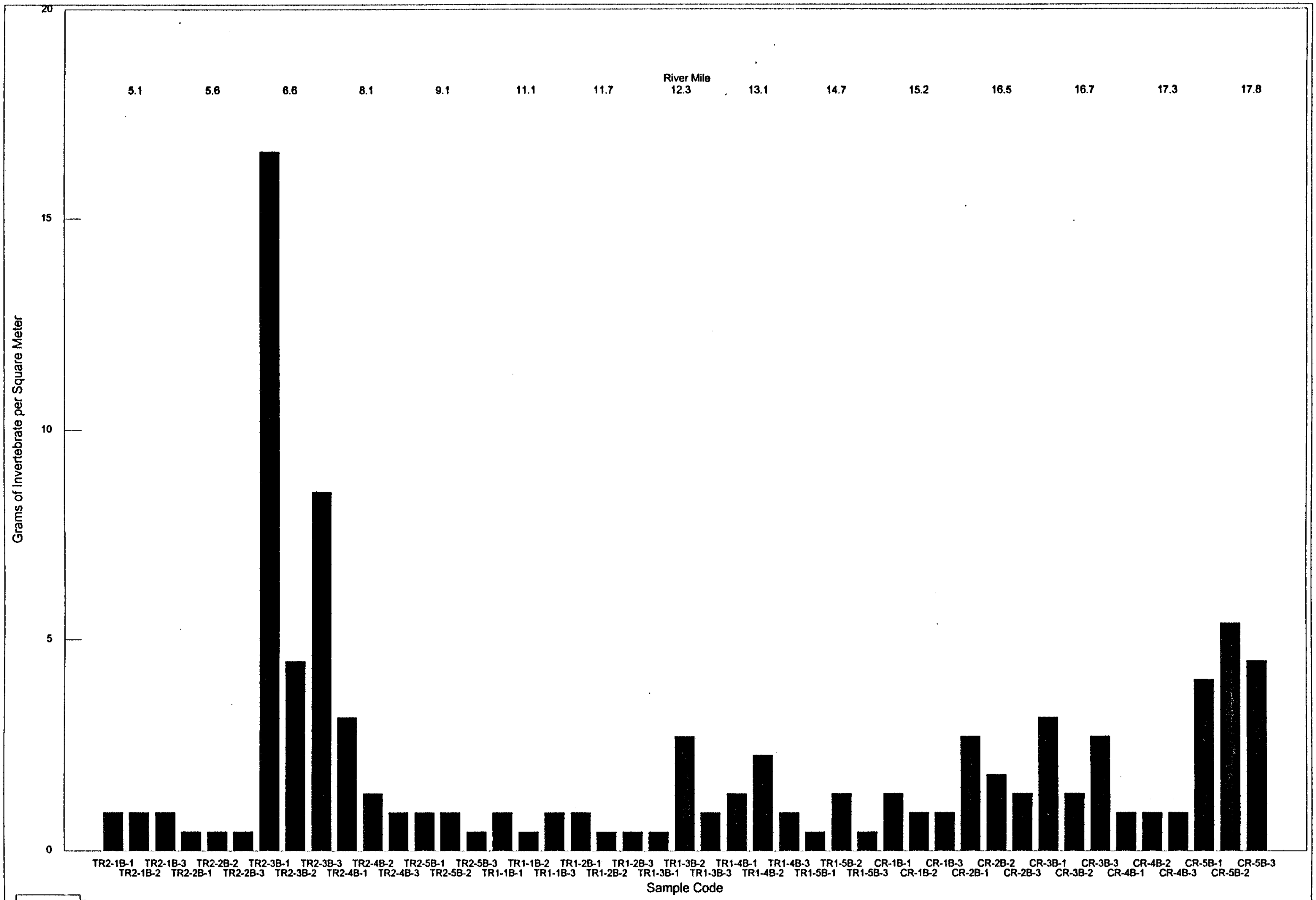


Figure 3.
Productivity

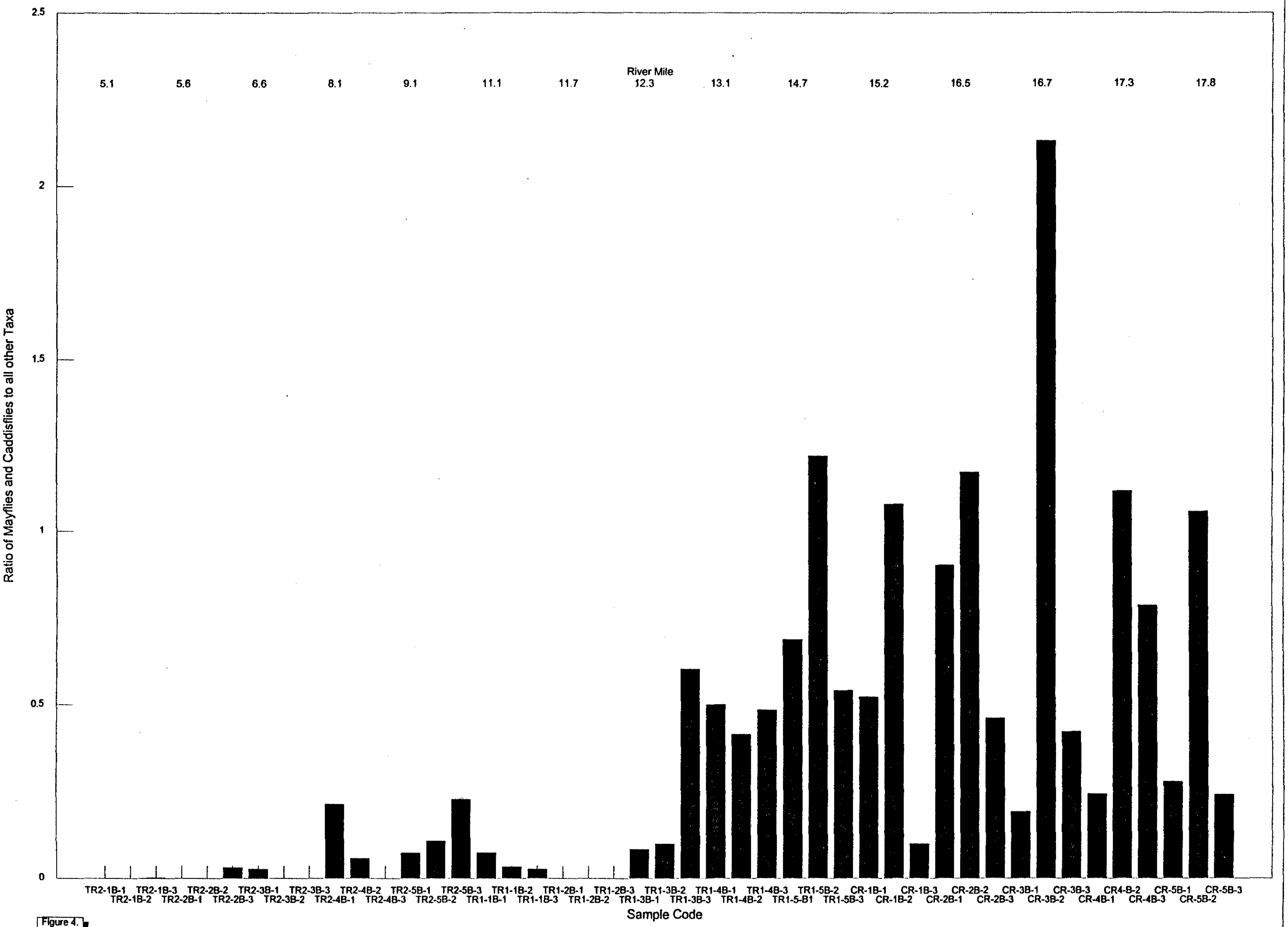
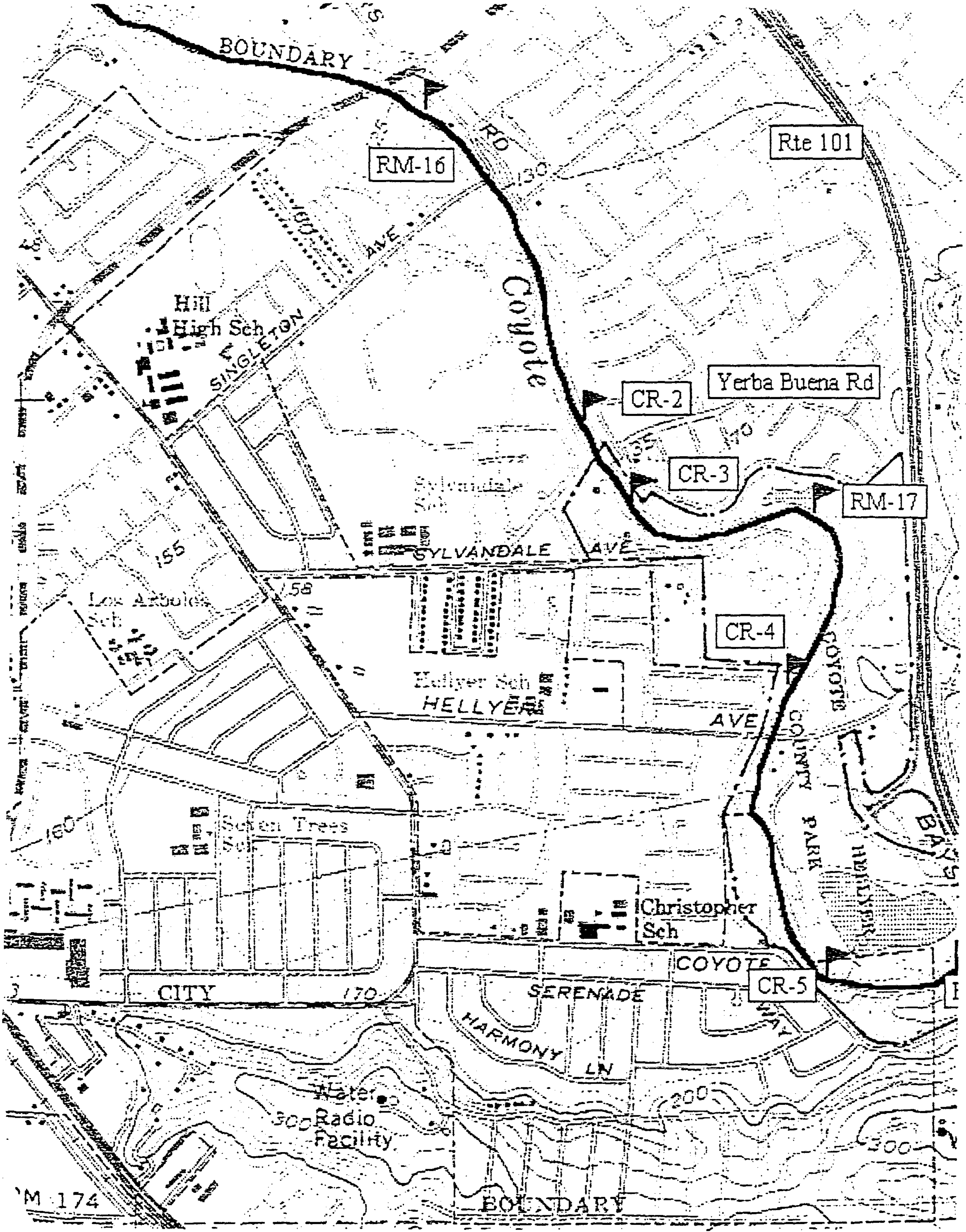


Figure 4.
EPT Ratio

APPENDIX A. MAPS OF SURVEY SITES



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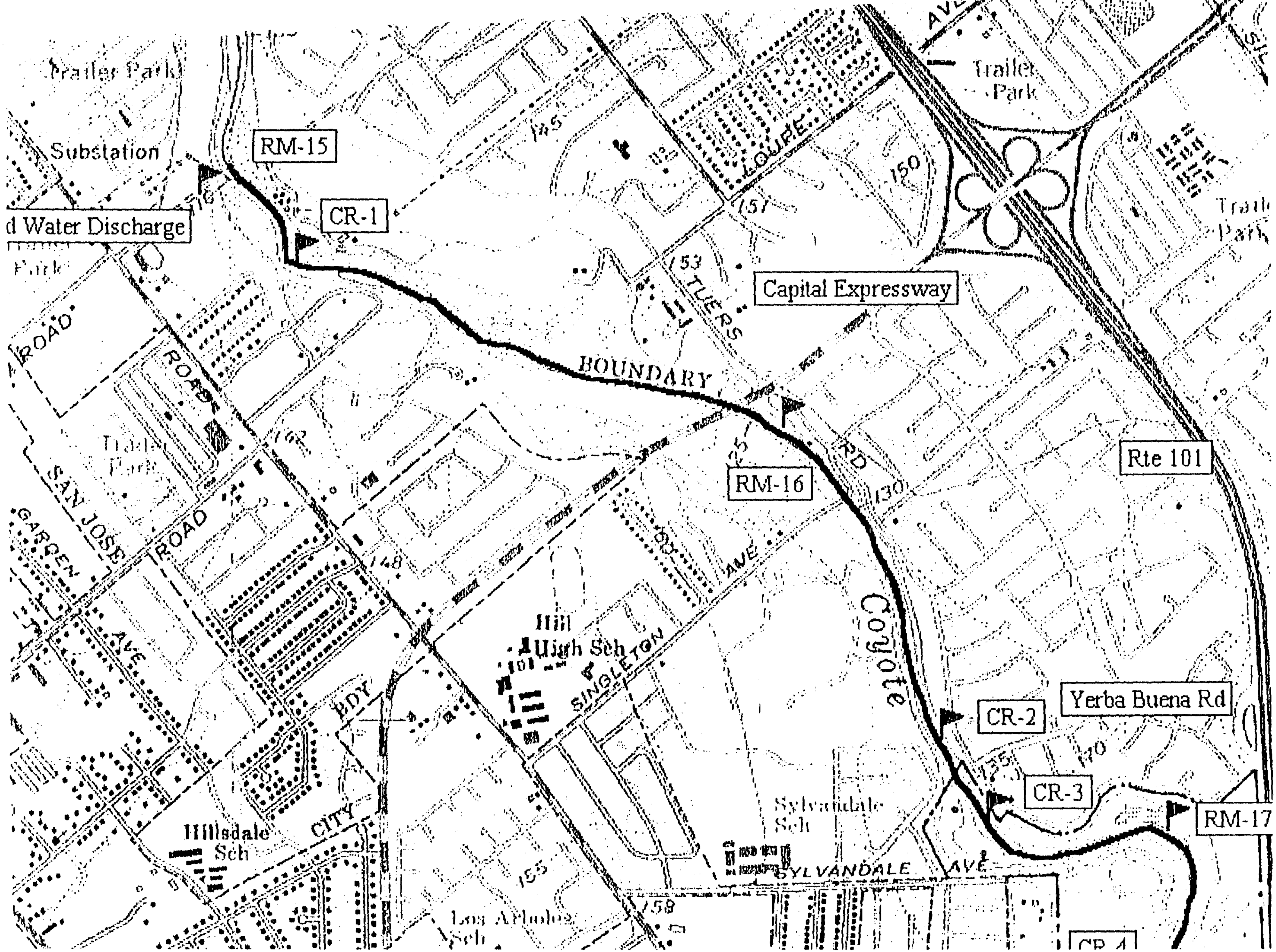

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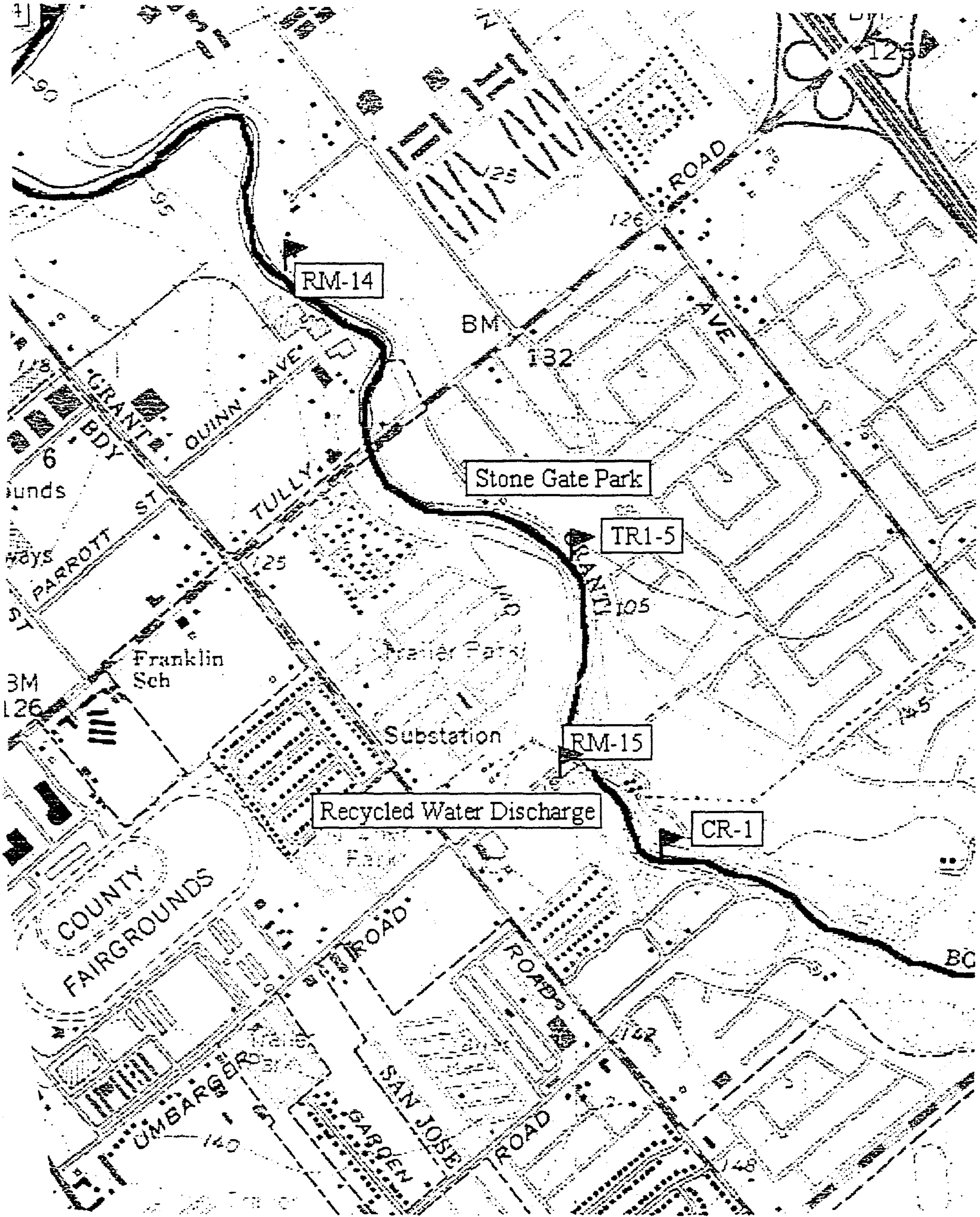

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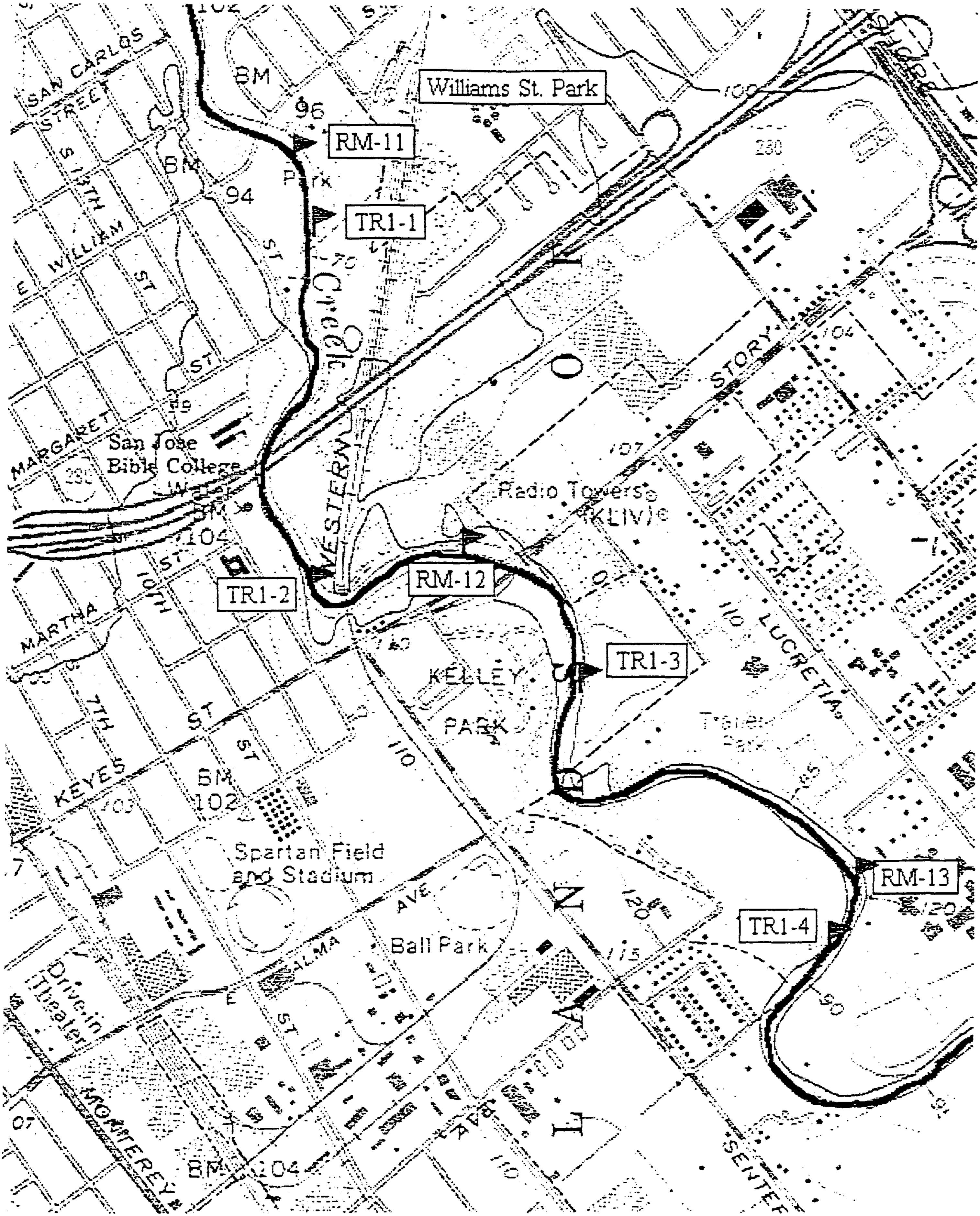

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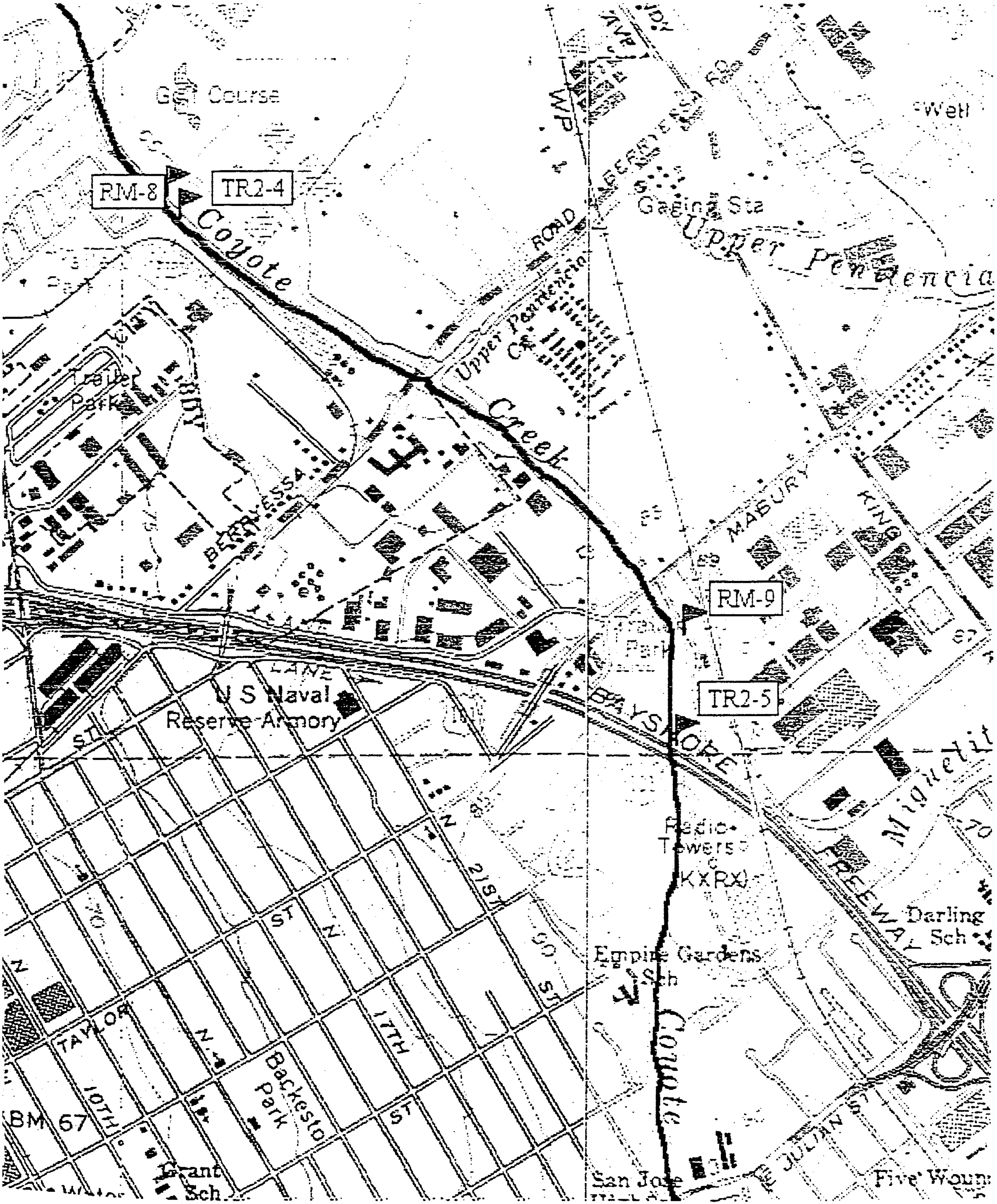

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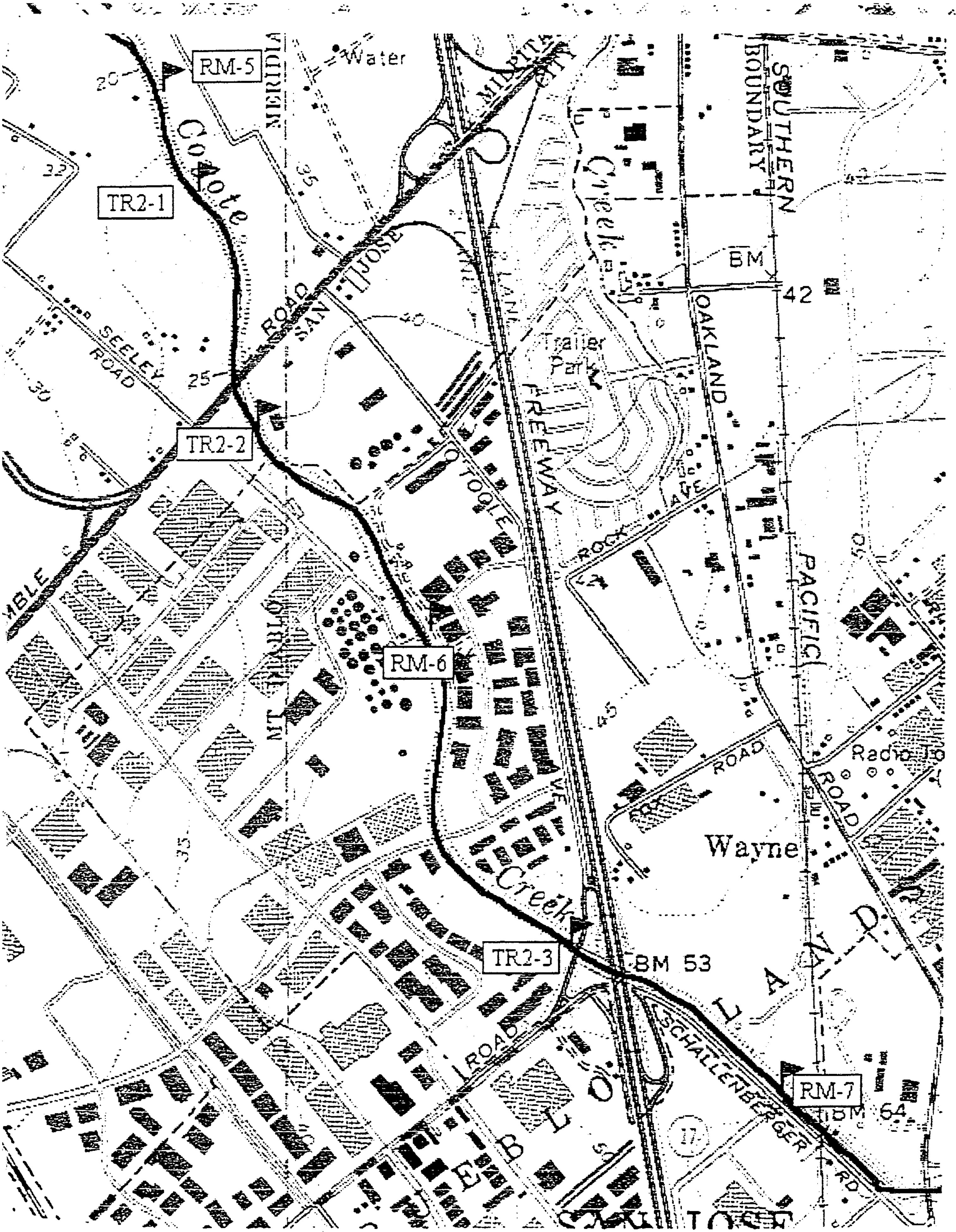

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DRAFT
COYOTE CREEK FLOW AUGMENTATION PILOT PROJECT
PHASE I FISHERIES MONITORING

Prepared for:

City of San Jose
Environmental Services Department
4245 Zanker Road, Ste L
San Jose, California 95134

Prepared by:

Scott Cressey
Fisheries Consultant
147 Ashbury Avenue
El Cerrito, California 94530
510-525-4389

In cooperation with:

LSA Associates, Inc.
157 Park Place
Pt. Richmond, California 94801
510-236-6810

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Appendix B. Aquatic Macroinvertebrate Report by Jones & Stokes Associates

1.0 INTRODUCTION

1.1 BACKGROUND

The San Jose /Santa Clara Water Pollution Control Plant (WPCP) presently discharges its treated effluent to South San Francisco Bay. Environmental concerns have resulted in the Regional Water Quality Control Board (RWQCB) ordering the WPCP to limit discharge to the South Bay and find alternative methods for disposal of the treated wastewater. The South Bay Water Recycling Program was created in 1992 in response to the RWQCB mandate and has been developed primarily for irrigation use. However, another use of the recycled water being considered is to augment the dry season flows of Coyote Creek. This approach is being investigated as the Stream Flow Augmentation Pilot Project (the Pilot Project), and it is scheduled to begin augmenting dry season flows in Coyote Creek in 1999. The anticipated point of augmentation for Coyote Creek is near Umbarger Road by the Santa Clara County Fair Grounds. This location is approximately 15 miles upstream of the tidally influenced zone below the Standish Dam site near Dixon Landing Road. Standish Dam is a summer dam that is usually installed during all but wet years to limit the upstream influence of tidal waters.

Approximately 32 miles upstream of Dixon Landing Road, Coyote Creek originates at Anderson Reservoir and flows north to South San Francisco Bay. The average gradient for this entire reach is 12.5 feet per mile, with the upper 17 miles having an average gradient of 17.1 feet per mile and the lower 15 miles (below Umbarger Road) averaging 7.3 feet per mile. Although the creek has extensive riparian vegetation along most of its length south of downtown San Jose, it begins to become an urban creek about 14 miles below Anderson Dam and becomes increasingly urbanized as it flows north. During the period of 1976 through 1995, Coyote Creek's highest average monthly flow of 124 cfs occurred in March and the peak flow during this period was 6,460 cfs. September and October flows during this same 20-year period averaged 2 to 4 cfs, but most water year records show no surface flow in Coyote Creek at Edenvale during the summer and early fall (District gage # SF58).

Recent assessments of water quality and fisheries concerns can be found in the Stream Flow Augmentation Pilot Project Addendum to the 1992 Final EIR for the San Jose Nonpotable Reclamation Project and its appendices (Parsons Engineering Science 1998) and a draft report by Merritt Smith Consulting (1998). The primary biological concern is the effect of the augmentation on ambient water temperature and how this might affect the two anadromous salmonid fishes that use Coyote Creek. The two species are the Central Valley fall-run chinook salmon (federally proposed as Threatened) and the Central California coast steelhead (federally listed as Threatened).

The Santa Clara Valley Water District (the District) and California Department of Fish and Game (CDFG) are jointly heading an effort to determine fish habitat management alternatives for the Guadalupe River, Coyote Creek, and Stevens Creek. This process is known as the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) and is just now beginning an extensive program of inventorying and monitoring physical habitat, water temperature, and fisheries. Other participants of FAHCE include the National Marine Fisheries Service, U.S. Fish and Wildlife Service, Natural Heritage Institute, and the City of San Jose. The FAHCE and WPCP's Pilot Project are working in coordination to minimize costs and maximize data usage.

The FAHCE aquatic inventory and monitoring program is, for the near future, focused primarily on the Guadalupe River. In contrast, the first 20 stream miles of Coyote Creek above Standish Dam have received very few aquatic surveys. Recent fisheries surveys within this reach are limited to a survey in the early 1990s in which Jones & Stokes sampled for juvenile steelhead in 2,000 feet of the lagoon upstream of Standish Dam. During the early 1980's the aquatic biota of the urbanized and upstream portions of Coyote Creek were sampled by Leidy (1984) and Pitt and Boozeman (1982). In the 1970s, the fisheries of Coyote Creek were sampled by Acettuno et al. (1976) and Scoppettone and Smith (1978). Prior to the 1990s, there was also limited fisheries sampling in Upper Penitencia Creek, a tributary of lower Coyote Creek (Smith 1998).

Because of the location of the recycled water release, flow augmentation in Coyote Creek could potentially benefit 15 miles of stream channel above tidal influence (Standish Dam). The fisheries Phase I monitoring study described below is closely interfaced with the FAHCE studies on the Guadalupe River which is also under evaluation to receive recycled water under a pilot project.

The ultimate goal of the WPCP's fisheries monitoring program for Coyote Creek is to determine if and how augmentation of dry season flows affect the stream's salmonid populations and habitat. During most of the anticipated period of flow augmentation (May 15 – October 15), salmonids potentially inhabiting the study reach are limited to juvenile steelhead. The exception to this is the potential for recycled water releases to act as an attractant to adult fall-run chinook salmon. Increased base flows and cooler temperatures resulting from flow augmentation could potentially attract chinook salmon from San Francisco Bay into Coyote Creek as early as August.

Phase I of the Coyote Creek fisheries monitoring program was initiated in the fall of 1998. This initial phase inventoried the treatment and control reaches of the creek. The study was designed such that, should sufficient numbers of juvenile steelhead and non-salmonid fishes be captured, these pre-project data of fish numbers can later be compared with post-project fish numbers and habitat conditions. Although water temperature and other water quality information is currently being collected from Coyote Creek by both the WPCP and the District, this program of water quality and hydrology data collection will be expanded during the Phase II monitoring effort beginning in 1999. Other components of the Coyote Creek monitoring program likely to be conducted in Phase II are detailed habitat mapping, spring and summer benthic invertebrate sampling, and upstream migrant trapping of fall-run chinook salmon. In the spring of 1999, the details of the Phase II monitoring effort will be developed based on the Phase I study results.

1.2 STUDY OBJECTIVES

The objectives of the WPCP's Phase I fisheries monitoring program are:

1. To inventory the fisheries and benthic invertebrates of the primary (0 – 5 miles below recycled water release) and secondary (5 – 10 miles below the release) treatment reaches and an upstream control reach of Coyote Creek.
2. To determine the similarity or differences between the biota of the treatment reaches and the control reach.
3. To develop a pre-project index of the numbers of the creek's juvenile steelhead and other summer resident fishes that could potentially be used in the assessment of the affects of flow augmentation on the salmonid populations of the creek.

These Phase I objectives are in support of the Phase II program's ultimate objective of accepting or rejecting the following null hypothesis: Coyote Creek dry season flow augmentation with recycled water has no effect on the creek's habitat conditions or its number of salmonids. The first alternative to this hypothesis is that the flow augmentation improves habitat conditions for salmonids and increases the number of juvenile steelhead in the creek. The second alternative to the hypothesis is that the flow augmentation adversely impacts habitat conditions for salmonids and decreases the number of juvenile steelhead in the creek. Factors evaluated in this assessment include:

- Numbers of juvenile steelhead
- Numbers of non-salmonid fishes that may compete with or prey upon juvenile steelhead
- Water temperature and general water quality conditions
- Aquatic macroinvertebrate populations.

Depending on the design of the Phase II program, additional factors that may be addressed in the assessment process include:

- Instream habitat quality, quantity, and mapping
- Riparian vegetation and shading
- Fall-run chinook salmon attraction flows

2.0 STUDY METHODS

The study approach recognizes that, as with most projects involving a flow release, the degree of impact is likely to change with distance downstream from the point of release. Water temperature, a key factor in the suitability of these streams as steelhead summer rearing habitat, is likely to change with distance and the degree of riparian shading occurring throughout the study reach. For this reason, the study plan divides the study area of Coyote Creek into subunits to represent "near, middle, and far" conditions within the 15-mile Treatment Reach. The Phase I fisheries and benthos effort is restricted to the near (primary) and middle (secondary) subunits of the Treatment Reach where the affect of augmented flow would be greatest. A "control" reach located immediately upstream of the point of flow augmentation provides an example of the waterway without flow augmentation.

2.1 STUDY AREA

The Coyote Creek Phase I study area consists of 10 river miles of Treatment Reach below the recycled water release point at Umbarger Road, and 3 river miles of Control Reach upstream of the release point (Map 1). The Treatment Reach is divided into two 5-mile sections with the primary treatment reach being termed Treatment Reach 1 and the secondary treatment reach being Treatment Reach 2. Using Standish Dam at Dixon Landing Road as river mile (RM) 0.0, Treatment Reach 2 encompasses RM 5 upstream to RM 10, and Treatment Reach 2 is from RM 10 upstream to RM 15 where the recycled water will be released. The Control Reach encompasses RM 15 upstream to RM 18.

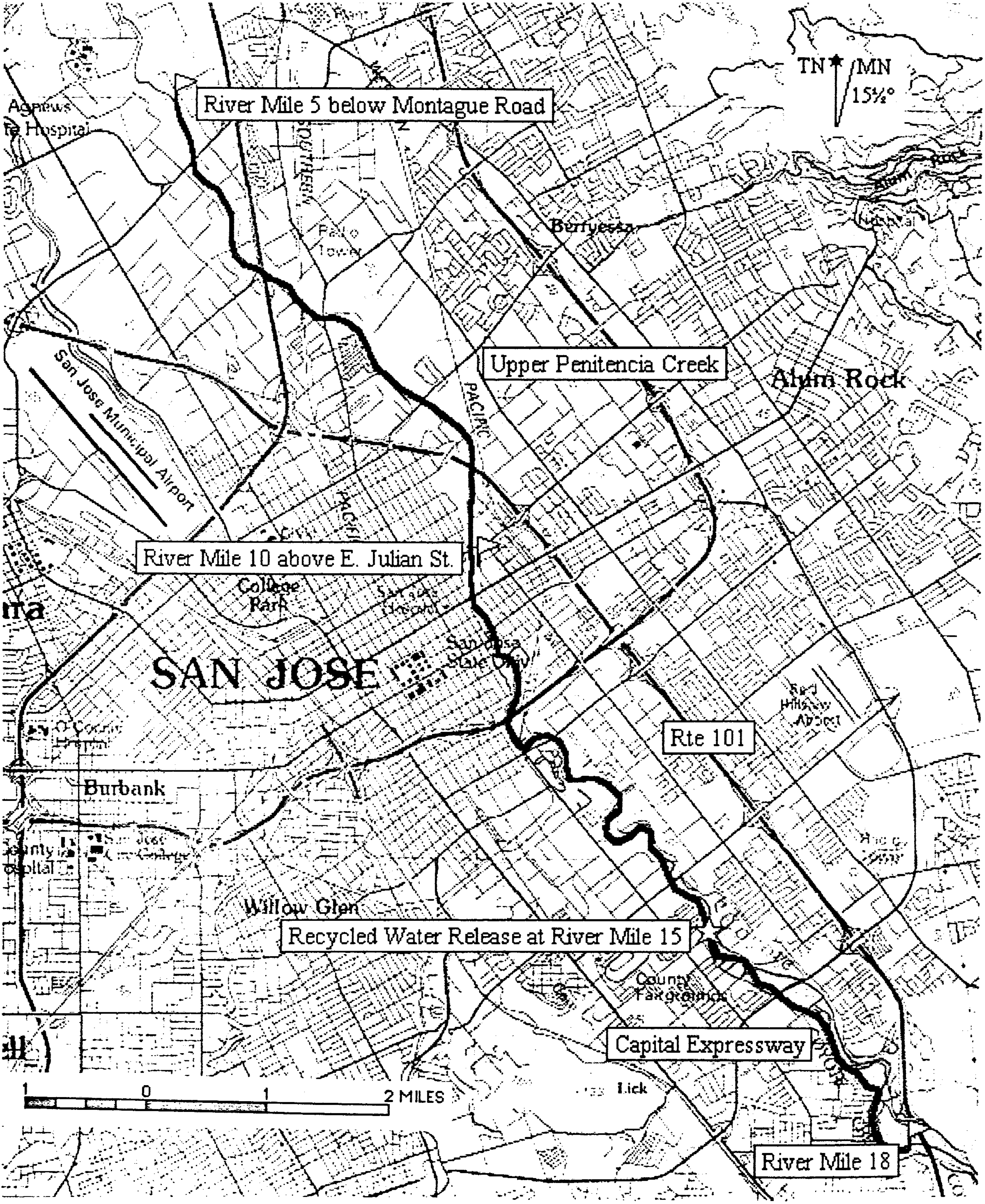
The Treatment Reach 2 is important because Upper Penitencia Creek, a tributary that supports steelhead, enters this reach at RM 8.5 (Berryesa Road). The first 5 miles above Dixon Landing Road (RM 0-5) received water quality monitoring only.

2.2 SAMPLE STATION SELECTION

The sampling station selection process randomly selected five sampling stations within Treatment Reach 1 (RM 10-15), Treatment Reach 2 (RM 5-10), and the control site (RM 15-18). Including the control site, this resulted in a total of 15 sampling stations on Coyote Creek.

The station locations were selected separately for each study reach through the following process. Portions of the creek with obvious access problems were identified from a map and rejected from the pool of candidate segments. The remaining reaches were divided into 0.1-mile segments on a topographical map and numbered consecutively. A random number table was then used to select the appropriate number of 0.1-mile segments to contain the sampling stations of each reach.

Prior to establishing a station in each 0.1-mile randomly selected segment, a site visit verified that the segment was accessible and contained a minimum of either riffle or run habitat in addition to the pool habitat that is prevalent throughout the three reaches.



Map 1. Coyote Creek Phase I Fisheries Monitoring Study Area, September 1998

Coyote Creek's instream habitat consists mostly of long pools upstream of bridge crossings, a short riffle immediately downstream of each bridge, and occasional run habitat where low flow channels occur. For this reason, the placement of the 300-foot sampling station in the field keyed on the least prevalent habitat, the riffle. Once the riffle component of the station was identified, the station was extended to encompass adjacent pool habitat and where possible, run habitat. Upon inspection in the field, a randomly selected stream segment may be rejected and replaced with another randomly selected segment for the following reasons:

- The segment is not accessible,
- The segment contains no reasonably accessible riffle or run habitat, or
- The pool habitat is too deep at base flow conditions to allow effective sampling by electrofishing or with a 6-foot deep beach seine.

Field inspection of the 15 randomly selected segments found that four had to be rejected because of accessibility and one was rejected because it contained only pool habitat. At one selected site (CR-1) an 8-foot deep pool separated adjacent habitats, so the 300-foot station was split into two sections to include habitats upstream and downstream of this pool. The lower one third of this pool was sufficiently shallow to electrofish and was included in the downstream portion of the station. The approximately 50-foot long deep portion of the pool was isolated by upstream and downstream block nets during sampling of this station.

Once the 300-foot sampling station was positioned within the selected stream segment, its upper and lower ends were photographed and marked with orange flagging and aluminum tags nailed to trees. The station's longitude and latitude coordinates were established for its upper and lower ends from onsite readings of a Global Positioning System (GPS) unit. The station length, width, and characteristics of the habitat were recorded. Within the station, each habitat type was measured and recorded along with water temperature.

2.3 FISH SAMPLING

If greater than 10 percent of a station's length, individual habitat types (i.e. pool, riffle, run) were sampled separately through the use of block nets top and bottom. This was to allow the fish population data to be extrapolated to the entire stream reach should quantitative habitat mapping be conducted in Phase II. Fish sampling was conducted using backpack electrofishing gear. One pool habitat with depths between 3.5 feet and 5 feet was sampled using a 150 X 6-foot beach seine with a ¼ - inch mesh. A three-pass depletion method was used to estimate the fish numbers and biomass in each station sampled. All captured fish were placed in live cars (holding pens) outside of the area being electrofished until the sampling was completed. Captured salmonids were to be kept in a live car separate from the other species captured. Special care was to be taken with the salmonids to minimize the risk of injury.

All captured fish were enumerated, weighed, measured, and then released back into the area sampled. When the captured non-salmonid species included more than 20 individuals of a similar species and size class, subsampling was employed. Fish were returned to the vicinity of their capture to the degree feasible. Captured salmonids were also to be fin clipped according to established protocols for obtaining tissue samples for genetic analyses.

2.4 AQUATIC MACROINVERTEBRATE SAMPLING

Benthic macroinvertebrate sampling at each station followed the California regional adaptation of the national U.S. EPA Rapid Bioassessment Protocols (CDFG 1996). The small length of the riffles encountered generally precluded following the protocols for randomly selecting transect locations in a riffle habitat. The process of collecting the kick samples at most stations disturbed most of the typically short section of riffle habitat. On longer riffles, transects were located to allow approximately 3 feet of undisturbed substrate between transect samples. Prior to disturbing the riffle through fish sampling, three 1-minute kick samples were collected with a D-frame kick net at the two margins and the center of the stream. The three samples were then combined to create one sample for each of the three transects across the riffle. The composite sample for each transect was washed in a 0.5 mm screen and large organic material was removed by hand while carefully inspecting it for clinging organisms. Each sample was then placed in a labeled container with 95 percent ethanol. A California Stream Bioassessment Procedure field worksheet was filled out for each sample station. The preserved samples were analyzed by Jones & Stokes Associates.

2.5 DATA ANALYSIS

Following the fish sampling activities, the collected fisheries data were processed to estimate fish population size and species composition. Because the macroinvertebrate and water temperature data were not available at the time of this report's preparation, they are not included at this time, but may be in a future edition. Bar graph and statistical analyses evaluated the similarity of the biota between the three study reaches, and that between stations.

Chi-squared tests were used to statistically analyze the fisheries data. This approach is appropriate for frequency of occurrence data (i.e., counts of objects), but does require a minimum numbers of occurrences in order to be accurate. Although a relatively large number of fish may be captured, the number of fish by species is unlikely to be evenly distributed throughout each station and reach. Low numbers of juvenile steelhead was a particular concern regarding whether sufficient numbers could be captured to allow a statistical assessment of the hypothesis.

Sparseness of certain fish species within the study area did not cause problems for the Phase I analysis, but low numbers of certain fishes could be a problem during the more complex analyses for Phase II. Therefore, the Phase I fish species were grouped into families and analyzed using these smaller groupings and greater numbers of individuals per family. Additionally, should small counts of certain families of non-salmonid fishes become problematic, these families may be excluded from further analyses. It may also prove necessary to look at fish counts within reaches only, rather than within individual sampling stations. Grouping the data in these ways, while reducing the precision of our analyses and the conclusions we can draw from them, will allow much more accurate estimates of changes occurring because of flow augmentation. A detailed description of the Phase I statistical analysis is provided in Section 3.3, with recommendations for analyzing the Phase II data provided in Section 5.

3.0 RESULTS AND DISCUSSION

3.1 STATION LOCATIONS AND HABITAT DESCRIPTION

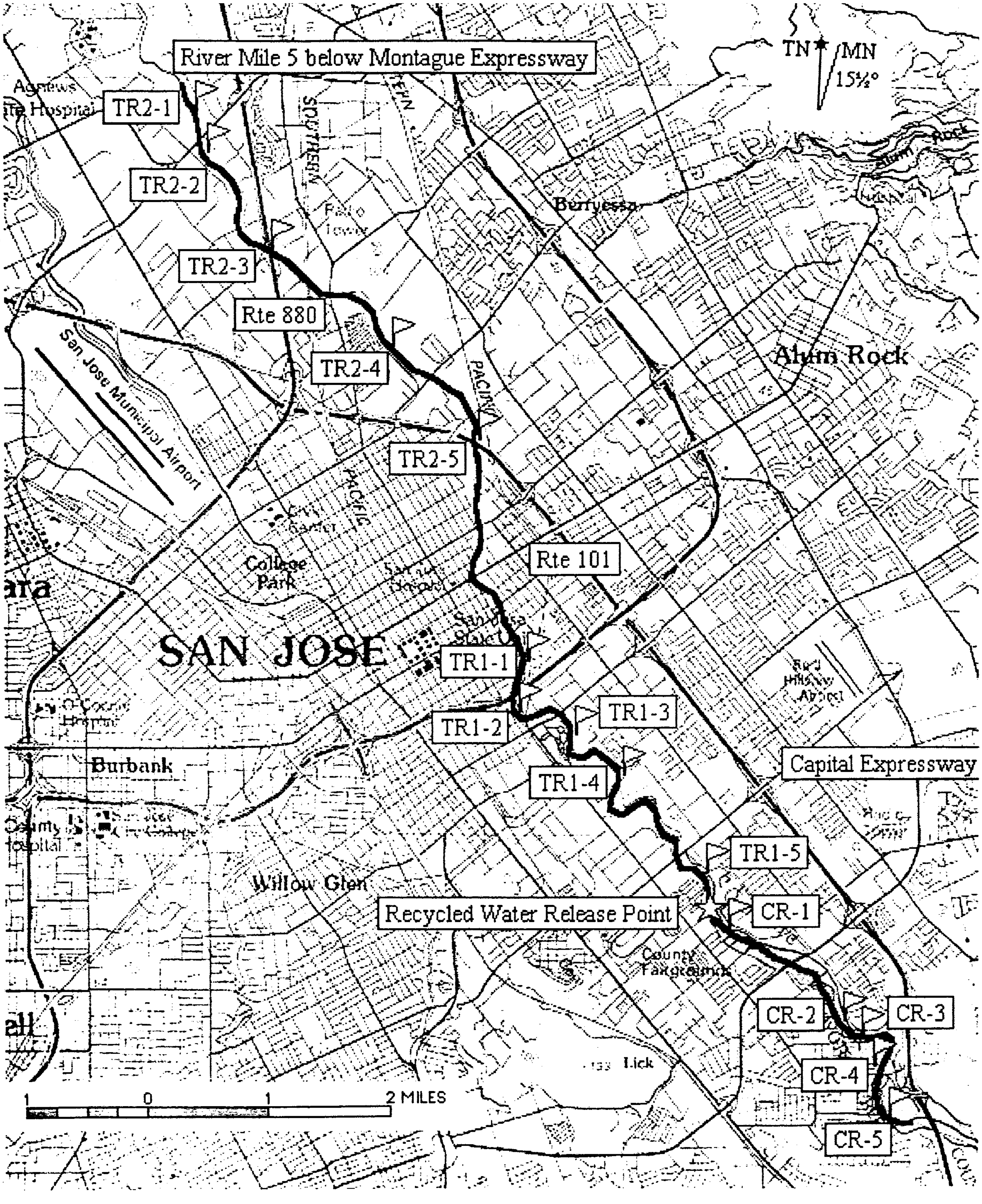
The locations of the fifteen sampling stations are shown on Map 2 at a scale of 1:63,360. The station locations are shown in greater detail (1:12,000 scale) on several maps in the Appendix A of this report.

The stations in the Treatment Reach closest to the recycled water release point are the TR1 series, while those further downstream are the TR2 series. Those stations in the Control Reach above the release point are shown as the CR series. Table 1 presents the descriptions, river mile location, and longitude and latitude for each of the 15 sampling stations. The numbering system used for the stations in each study reach begins at the lower end and proceeds upstream.

The most prevalent habitat throughout the study area is pool habitat. Long, slow pools with a silt/clay substrate are typical of all three component study reaches. Sand/silt are common substrates in the lowermost stations of the TR2 series, and a few cobbles occur in the uppermost station (CR5). Riffles are very rare and are in most sampling stations only because the station selection began with identifying a riffle in the randomly selected segment and extending it into the adjacent pool habitat. Riffle substrate was primarily gravel ranging from 10 to 30 mm, with a few riffles being comprised of 150 mm diameter cobble that are embedded 40 percent into the underlying finer substrate. Run habitat was also infrequent and was most extensive at Station CR1.

Boulders were lacking in the stream, and instream cover was provided by large woody debris and man-made objects such as shopping carts. Particularly valuable as cover to the fishes are the tree roots that line portions of the stream bank. Young bass and sunfish were most numerous in association with the root-lined stream banks, and even when undercut, stream banks without tree roots supported few fish.

The aquatic sampling was conducted from September 24 to October 3, 1998 with flows of 3 to 5 cubic feet per second (cfs). Water temperatures taken when sampling each station ranged from 16 degrees C to 20.6 degrees C and averaged 18 degrees C. The lowest and highest temperatures were from TR1-4 and TR1-5, respectively. Collected on the same day, the low temperature was taken at 1117 hours and the high at 1400 hours. The average temperatures for each of the three study reaches from downstream to upstream are, respectively: 18.8 degrees C, 17.8 degrees C, and 17.3 degrees C. Specific electrical conductivity in early September ranged from 400 umhos/cm in the upper study area to 1200 umhos/cm in the lower reach. Additional temperature and conductivity data will be available from the WPCP's installation of a hydrolab at various locations in Coyote Creek.



Map 2. Coyote Creek Phase I Fisheries Monitoring Stations, September 1998

Table 1
COYOTE CREEK PHASE I FISH MONITORING STATIONS' LOCATION
September-October 1998

Reach	Station	River Mile	Description	Latitude and Longitude		
				Lower End	Upper End	Riffle
RM 5-10	TR2-1	5.1	River Oaks Park	37° 24' 01" 121° 54' 57"	37° 24' 02" 121° 54' 54"	37° 24' 02" 121° 54' 54"
	TR2-2	5.6	Upstream of Montague Expressway Bridge	37° 23' 43" 121° 54' 51"	37° 23' 41" 121° 54' 50"	37° 23' 43" 121° 54' 51"
	TR2-3	6.6	Below Brokaw Road	37° 23' 02" 121° 54' 18"	37° 22' 58" 121° 54' 13"	37° 23' 02" 121° 54' 18"
	TR2-4	8.1	Between golf course and Berryessa Road	37° 22' 20" 121° 53' 11"	37° 22' 17" 121° 53' 16"	37° 22' 17" 121° 53' 16"
	TR2-5	9.1	Above Mabury Rd. near City Corp. Yard	37° 21' 39" 121° 52' 20"	37° 21' 33" 121° 52' 21"	37° 21' 35" 121° 52' 21"
RM 10-15	TR1-1	11.1	Williams Street Park	37° 19' 59" 121° 51' 58"	37° 20' 05" 121° 51' 52"	37° 19' 59" 121° 51' 58"
	TR1-2	11.7	Between Rte 280 and Story Road	37° 19' 37" 121° 51' 58"	37° 19' 38" 121° 51' 57"	37° 19' 37" 121° 51' 58"
	TR1-3	12.3	Lower Kelley Park	37° 19' 29" 121° 51' 31"	37° 19' 27" 121° 51' 32"	37° 19' 29" 121° 51' 31"
	TR1-4	13.1	Upper Kelley Park	37° 19' 11" 121° 51' 06"	37° 19' 08" 121° 51' 07"	37° 19' 09" 121° 51' 06"
	TR1-5	14.7	Stone Gate Park	37° 18' 28" 121° 50' 17"	37° 18' 28" 121° 50' 11"	37° 18' 29" 121° 50' 18"
RM 15-18	CR-1	15.2	Horseshoe Club, 0.2 mi. above Umbarger Road Station is split by a deep pool.			
			Lower Portion	37° 19' 59" 121° 51' 58"	37° 18' 06" 121° 50' 08"	37° 18' 07" 121° 50' 10"
			Upper Portion	37° 18' 07" 121° 50' 08"	37° 18' 05" 121° 50' 05"	
	CR-2	16.5	Below Yerba Buena Road Riffle is immediately below bridge	37° 17' 27" 121° 49' 03"	37° 17' 27" 121° 49' 05"	37° 17' 26" 121° 49' 02"
	CR-3	16.7	County Park above Yerba Buena Road	37° 17' 21" 121° 49' 02"	37° 17' 21" 121° 49' 00"	37° 17' 23" 121° 49' 00"
	CR-4	17.3	County Park downstream of Hellyer Avenue	37° 17' 27" 121° 49' 04"	37° 17' 26" 121° 49' 03"	37° 17' 26" 121° 49' 03"
	CR-5	17.8	County Park west of Cottonwood Lake	37° 16' 41" 121° 48' 44"	37° 16' 44" 121° 48' 40"	37° 16' 44" 121° 48' 41"

3.2 AQUATIC MACROINVERTEBRATES

The Jones & Stokes Associates report (Jones & Stokes 1998) analyzing the aquatic macroinvertebrate samples is provided in Appendix B of this report. The average density of aquatic invertebrates was 266 organisms per square meter, with a high of 888 organisms per square meter and a low of 23 organisms per square meter. The highest densities in each of the three study reaches occurred at Stations TR2-1, TR1-5, and CR-4, with the freshwater clam, *Corbicula* sp., comprising the majority of the organisms at all three of these stations.

Taxa richness is the total number of individual taxa per sample and is an indicator of the overall health of the aquatic habitat. The average taxa richness for all samples was 17.26 with a range of 34.09 to 5.38. Benthic macroinvertebrate productivity is defined as the grams of living invertebrates per square meter within the study area. The average productivity for the Coyote Creek study area was 1.97 grams, with a range of 8.52 grams to 0.45 grams.

Relative aquatic habitat health can be determined by measuring the abundance of invertebrate families most sensitive to changes in water quality and habitat. The EPT (Ephemeroptera [mayflies], Plecoptera [stoneflies], Trichoptera [caddisflies]) index focuses on the ratio of the nymphal abundance of these three orders to that of all other taxa. The EPT invertebrates are pollution sensitive and their abundance increases with increasing water quality. None of the sampling stations contained stoneflies, and only 34 or the 45 samples contained mayflies or caddisflies. The highest EPT indices were from TR1-5 and CR-3. The overall paucity of EPT taxa may indicate that the study area contains low quality habitat for aquatic invertebrates.

Chinese mitten crab, a newly introduced exotic species, was common throughout the entire study area, but appeared to be more numerous in the lower stations than the uppermost stations. Crayfish were also common at most stations. Although crayfish appeared to be more prevalent at certain stations than others, this may be an artifact of the water depth and stream bank slope which can affect how visible crayfish are to the observer. At the time of sampling, the water was always turbid and visibility was only 8-10 inches (20-25 cm).

3.3 FISHERIES

The results of the fish sampling by electrofishing and the seining of one deep pool are summarized in Table 2. The fish species captured are listed below with the native fishes indicated by (N):

Lamprey (juv. only) (N)	*Lampetra* sp.
California roach (N)	*Hesperoleucus symmetricus*
Hitch (N)	*Lavinia exilicauda*
Red shiner	*Notropis lutrensis*
Carp	*Cyprinus carpio*
Sacramento sucker (N)	*Catostomus occidentalis*
Mosquitofish	*Gambusia affinis*
Bluegill	*Lepomis macrochirus*
Green sunfish	*Lepomis cyanellus*
White crappie	*Pomoxis annularis*
Largemouth bass	*Micropterus salmoides*
Smallmouth bass	*Micropterus dolomieui*
Yellowfin goby	*Acanthogobius flavimanus*
Sculpin (N)	*Cottus* sp.

No steelhead (*Oncorhynchus mykiss*) were captured or observed. However, on October 1 an adult chinook salmon (*Oncorhynchus tshawytscha*) estimated at 6-7 pounds was closely observed moving upstream through the large riffle just above the Montague Expressway.

The most numerous fish species captured in the study reach was the California roach, a native minnow. Another prevalent native minnow species was the hitch. These two fish species, plus less numerous minnows such as carp and red shiner, caused fishes of the minnow family to comprise 70 percent of the fishes captured from the entire study reach. The sunfish family was the second largest family of fishes in the study reach at 22 percent of the total numbers captured. The most abundant members of the sunfish family were green sunfish, largemouth bass, and smallmouth bass.

However, these fish families were not distributed evenly throughout the study reach. Yellowfin goby were captured only in the lowermost three stations of the TR2 reach (Figure 1). The minnow family, primarily California roach and hitch, became progressively more numerous as the sampling stations ascended Coyote Creek (Figures 1 and 2), but dropped substantially in percent composition within the Control Reach (Figure 3). Perhaps because of a greater abundance of tree roots along the banks of pool habitat, the sunfish family is notably abundant in the Control Reach compared to downstream stations. Most of the largemouth and smallmouth bass are young-of-the-year and 1+ year classes of fish as shown below in Table 3 and in Figure 4.

Table 2
FISH SAMPLING RESULTS, COYOTE CREEK PHASE I FISH MONITORING,
September 24 - October 3, 1998

Sampling Station	River Mile[1]	Location Description	Station Length (ft)	Total Fish Captured	Population Estimate[2]	Captured Fish per 100 feet	Estimated Fish per 100 feet[3]	Fish Composition		Numbers Captured	*Table 2, Page 1 of 3* Comments
								Species	Percent		
TR2-1	5.1	River Oaks Park	300	16	16	5.3	5.3	Yellowfin goby	31%	5	Riffle = 1 hitch only.
		Pool	180	15	Error[4] = 1.0			Hitch	31%	5	Remainder fish from
		Riffle	120	1				LM bass	12%	2	pool habitat.
								Carp	12%	2	
								Calif. Roach	12%	2	
TR2-2	5.6	Above Montague Rd	270	34	*	12.6	*	Yellowfin goby	65%	22	Pool = 2 goby & 1 GSF
		Pool	90	3	Error =48			Lamprey (juv)	29%	10	Remainder from riffle.
		Riffle	180	31				Hitch	3%	1	Observed chinook salmon
								Green sunfish	3%	1	of 6-7 lb. in riffle.
TR2-3	6.6	At Brokaw Rd	300	14	17	4.7	5.7	Yellowfin goby	36%	5	
		Pool	265	7	Error = 5.0			Calif. Roach	21%	3	
		Riffle	35	7				Sculpin	21%	3	
								Lamprey (juv)	7%	1	
								LM bass	7%	1	
								Hitch	7%	1	
TR2-4	8.1	Below Berryessa Rd	310	106	125	34.2	40.3	Calif. Roach	78%	83	No fish from riffle.
		Pool	300	106	Error = 10.2			Sac. Sucker	16%	17	
		Riffle	10	0				Hitch	4%	4	
								Green sunfish	1%	1	
								LM bass	1%	1	
TR2-5	9.1	Above Mabury Rd	340	25	26	7.4	7.6	Calif. Roach	64%	16	130 ft of riffle are under the
		Pool	60	0	Error = 2.0			Sac. Sucker	24%	6	overpass.
		Riffle	280	25				Green sunfish	8%	2	No fish found in pool.
								LM bass	4%	1	
TR!-1	11.1	Williams Street Park	315	196	235	62.2	74.6	Calif. Roach	92%	180	No fish found in riffle.
		Pool	300	196	Error = 15.6			Hitch	5%	10	
		Riffle	15	0				Green sunfish	2%	4	
								Mosquitofish	1%	2	
TR1-2	11.7	At RR below Story Rd	300	101	107	33.7	35.7	Calif. Roach	88%	89	About 95% of fish were
		Pool	208		Error = 4.0			Hitch	10%	10	found in the run habitat.
		Run	92					LM bass	2%	2	

								Red shiner	1%	1	

Sampling Station	River Mile[1]	Location Description	Station Length (ft)	Total Fish Captured	Population Estimate[2]	Captured Fish per 100 feet	Estimated Fish per 100 feet[3]	Fish Composition		Numbers Captured	*Table 2, Page 2 of 3* Comments
								Species	Percent		
TR1-3	12.3	Lower Kelley Park	300	56	77	18.7	25.7	Calif. Roach	57%	32	Small numbers of roach
		Pool	295		Error = 16.2			Hitch	20%	11	found along riffle margins.
		Riffle	5					Mosquitofish	14%	8	Remainder of catch from
								LM bass	3%	2	pool habitat.
								Sac. Sucker	2%	1	
								Lamprey (juv)	2%	1	
								Carp	2%	1	
TR1-4	13.1	Upper Kelley Park	315	117	159	37.1	50.5	Calif. Roach	79%	92	Most of the roach were
		Pool	305		Error = 21.9			Green sunfish	6%	7	found in moderate current
		Riffle	10					Hitch	5%	6	at the margins of the riffle.
								Sac. Sucker	3%	4	
								LM bass	3%	3	
								Carp	3%	3	
								Mosquitofish	1%	1	
								Bluegill	1%	1	
TR1-5	14.7	Stone Gate Park	300	150	181	50	60.3	Calif. Roach	83%	124	Caught two bass and two
		Pool	245		Error = 13.8			LM bass	5%	8	lampreys in the run. Few
		Riffle	15					Green sunfish	4%	6	fish caught in gravel riffle.
		Run	40					Hitch	3%	5	
								Lamprey (juv)	3%	4	
								Mosquitofish	1%	2	
								Sac. Sucker	1%	1	
CR-1	15.2	Horseshoe Club	320	58	67	18.1	20.9	Hitch	52%	30	Most fish from pools and
		Pool	121		Error = 6.8			Calif. Roach	31%	18	slow margins of runs.
		Riffle	14					Green sunfish	5%	3	
		Run	185					LM bass	3%	2	
								Lamprey (juv)	3%	2	
								Carp	3%	2	
								Sac. Sucker	2%	1	
CR-2	16.5	Below Yerba Buena Rd	330	68	94	20.6	28.5	Green sunfish	37%	25	Almost no fish in riffle.
		Pool	300		Error = 18.2			SM bass	25%	17	
		Riffle	30					LM bass	19%	13	
								Hitch	9%	6	
								Sculpin	6%	4	
								Sac. Sucker	1%	1	
								Calif. Roach	1%	1	
								Mosquitofish	1%	1	

Table 2, Page 3 of 3

Sampling Station	River Mile[1]	Location Description	Station Length (ft)	Total Fish Captured	Population Estimate[2]	Captured Fish per 100 feet	Estimated Fish per 100 feet[3]	Fish Composition		Numbers Captured	Comments
								Species	Percent		
CR-3	16.7	County Park, north end	300	22	32	7.3	10.7	LM bass	50%	11	Almost no fish in riffle.
		Pool	270		Error = 13			SM bass	32%	7	
		Riffle	30					Green sunfish	9%	2	
								Sac. Sucker	9%	2	
CR-4	17.3	County Pk below Hellyer	274								
		Pool seined	59	80	*	135.6	*	Green sunfish	76%	61	Larval GSF were 21 of 61.
								Calif. Roach	9%	7	All roach were larvae.
								Hitch	5%	4	Bass were juveniles.
								SM bass	5%	4	Third seine haul had the
								White crappie	4%	3	highest catch.
								LM bass	1%	1	
		Pool electrofished	64	29	30	45.3	46.9	Green sunfish	52%	15	Roach was larval.
					Error = 1.7			LM bass	34%	10	One LMB was 365 mm.
								SM bass	7%	2	One LMB was 217 mm.
								Hitch	3%	1	Other bass are YOY[5].
								Calif. Roach	3%	1	
		Riffle	151	6	6	4	4	LM bass	50%	3	Mostly shallow gravel riffle
					Error = 0.1			SM bass	17%	1	Bass were YOY.
								Green sunfish	17%	1	
								Sculpin	17%	1	
CR-5	17.8	County Pk west of lake	300	19	22	6.3	7.3	LM bass	42%	8	Few fish found in riffle.
		Pool	292		Error = 4.3			Green sunfish	37%	7	LMB included YOY, 1+, &
		Riffle	8					Hitch	16%	3	larger to 230 mm.
								Sculpin	5%	1	

[1] River miles are measured upstream from Standish Dam.

[2] Estimated using Van Deventer and Platts' (1886) Microfish Interactive Program (a multiple pass depletion formula), Version 3.0.

[3] Fish per 100 feet is calculated from the fish population estimate numbers.

[4] Error refers to the Standard Error calculated for the population estimate.

[5] YOY stands for Young-of-the-Year, those fish that are not yet one year old.

* If the population estimate is worthless because of a high level of probable error (C.I. = 95%), it is not included.

Table 3
Coyote Creek Bass Year Class Composition, All Stations, September 1998

Year Class	Largemouth Bass (N=58)		Smallmouth Bass (N=30)	
	Size Range (mm)	Percent of Total	Size Range (mm)	Percent of Total
Young of Year	<100	59%	<130	80%
1+	101-180	26%	131-180	20%
2+	181-280	14%		
3+	281-340	0%		
4+	340-410	2%		

Note: Size ranges for year class are based on Figure 4 and Carlander's (1977) compilation of data from various states.

Mosquitofish were captured at five sites, primarily in the TR1 reach, with the highest number at TR1-3 (Figure 5). Juvenile lamprey, either Pacific lamprey (*L. tridentata*) or Pacific brook lamprey (*L. pacifica*) were found at several sites upstream as far as Station CR-1 with the greatest number captured at TR2-2 (see Figure 5). These juvenile lamprey are filter feeders that burrow into the soft silt and are rarely seen above ground. The number of juvenile lamprey captured is not a good indicator of their abundance in Coyote Creek. This is because: 1) lamprey's small size (typically 92 mm) and worm-like body shape makes them difficult to see in the turbid water; 2) their size and body shape allows them to pass through the mesh of the dip nets; and 3) because they were burrowed in the silt, it sometimes took more than one pass for the electrical current to drive them out of their burrow.

Statistical Analysis

The Phase I statistical analyses are designed to confirm the similarity or differences between biota of the treatment reaches and the control reach (this was stated as the second objective in Section 1.2). A visual inspection of Figures 1 through 3 indicate there are substantial differences between reaches. A chi-square test of independence by family and reach shows this difference to be highly significant (Likelihood Ratio Chi-square=663.2, df=10, p<0.001), thereby rejecting the null hypothesis that families are distributed equally between the reaches (see Table 4 for the numbers of fish by family and reach). The likelihood ratio shown above has been reported rather than the Pearson chi-square statistic in order to more easily compare these results to those that will be found in Phase II, when log-linear analyses will require the use of the likelihood ratio. The two statistics are comparable, although the likelihood ratio is slightly more conservative. The small counts in certain cells, such as for the gobies in two of the three reaches, cast very little doubt on such a strong result.

Table 4
Coyote Creek Fish Numbers by Family and Reach, September 1998

Family	Treatment Reach 2	Treatment Reach 1	Control Reach	Totals
Minnow	117	564	73	754
Sucker	23	6	4	33
Goby	32			32
Sunfish	9	33	196	238
Sculpin	3		6	9
Lamprey	11	5	2	18
Totals	195	608	281	1084

Figure 1
Coyote Creek Fish Composition, TR2 Series, September 1998

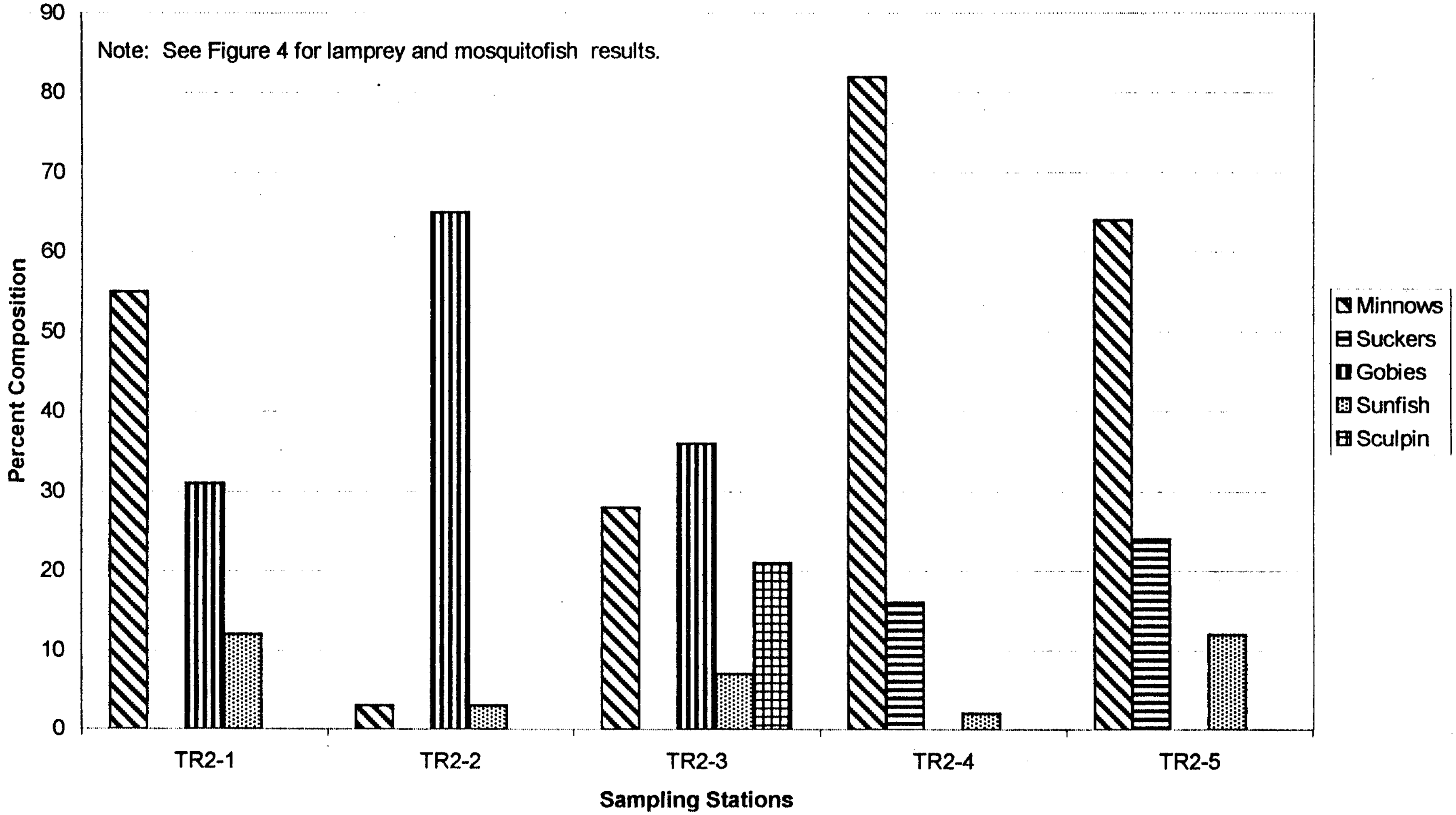
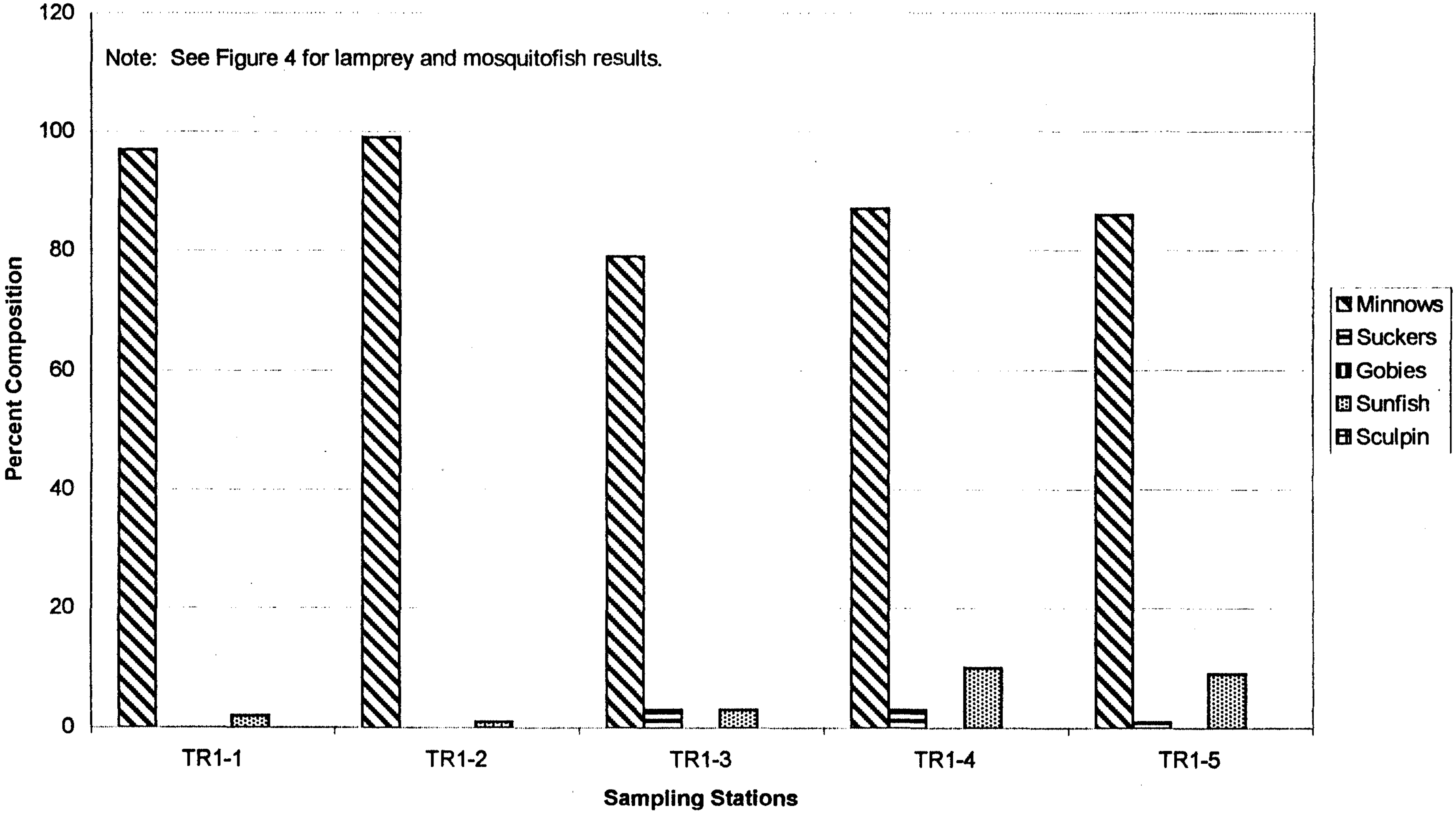


Figure 2
Coyote Creek Fish Composition, TR1 Series,
September 1998



Note: See Figure 4 for lamprey and mosquitofish results.

Figure 3
Coyote Creek Fish Composition, CR Series, September 1998

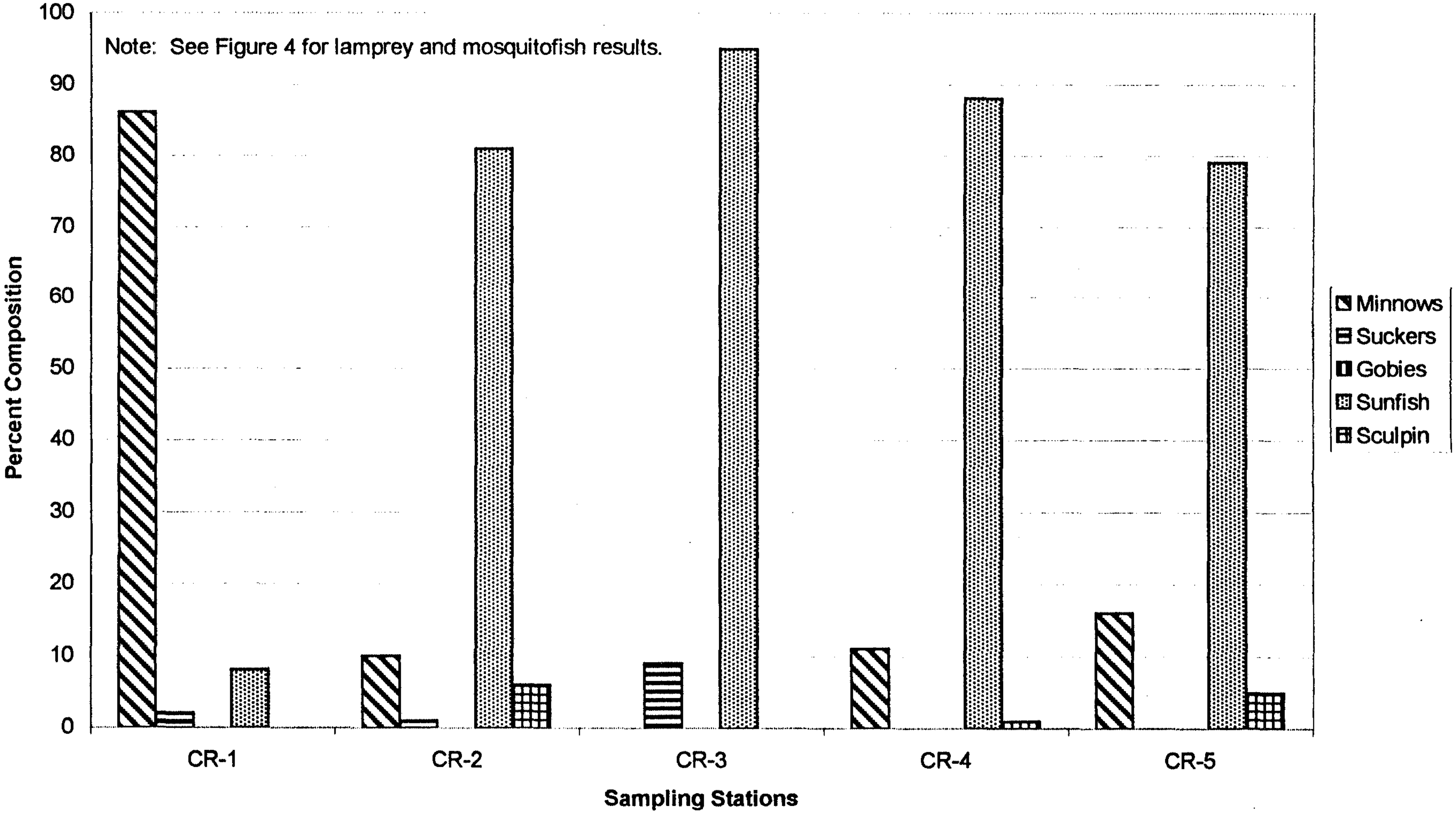


Figure 4
Coyote Creek Largemouth and Smallmouth Bass Size Frequency, September 1998

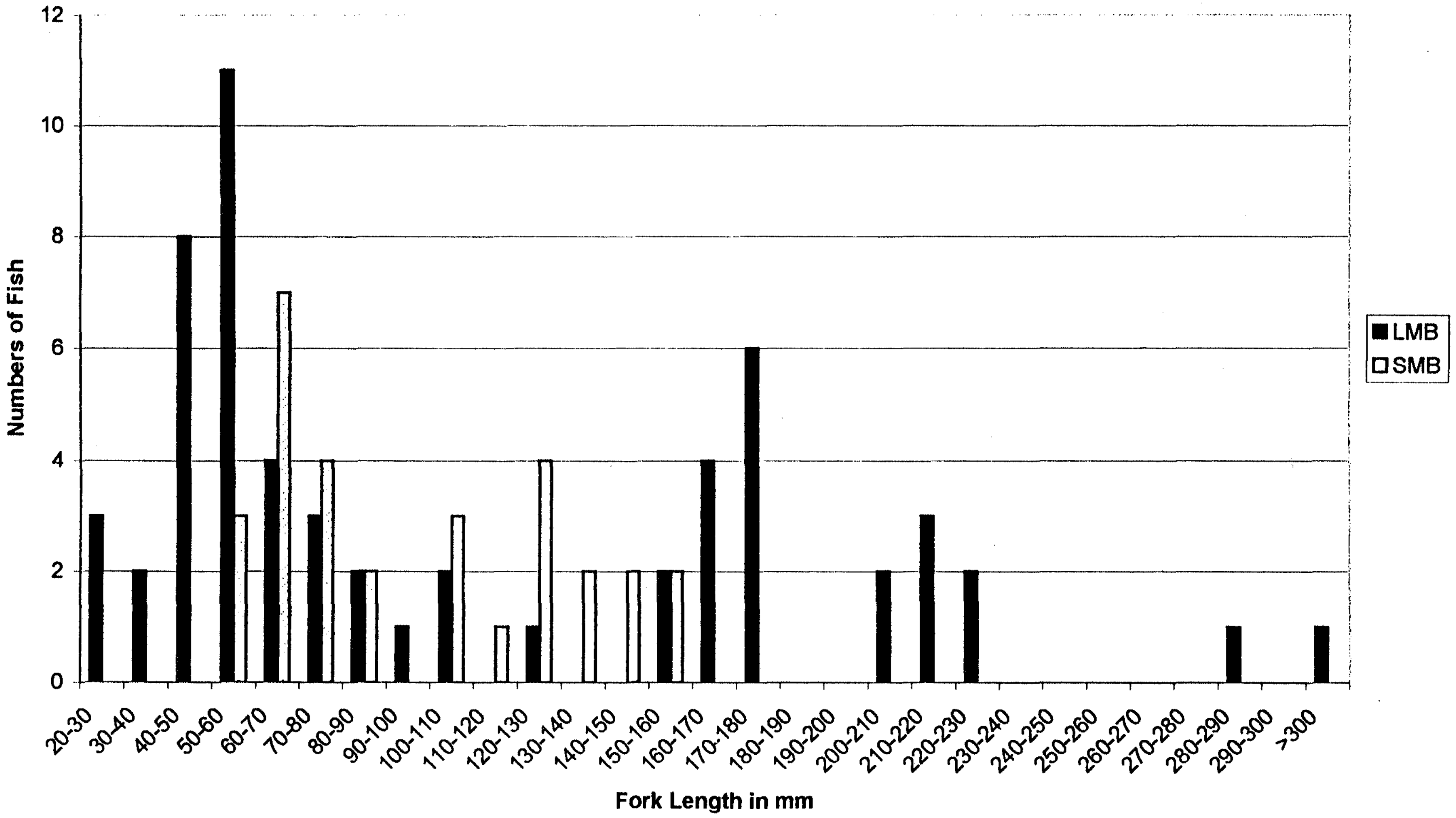
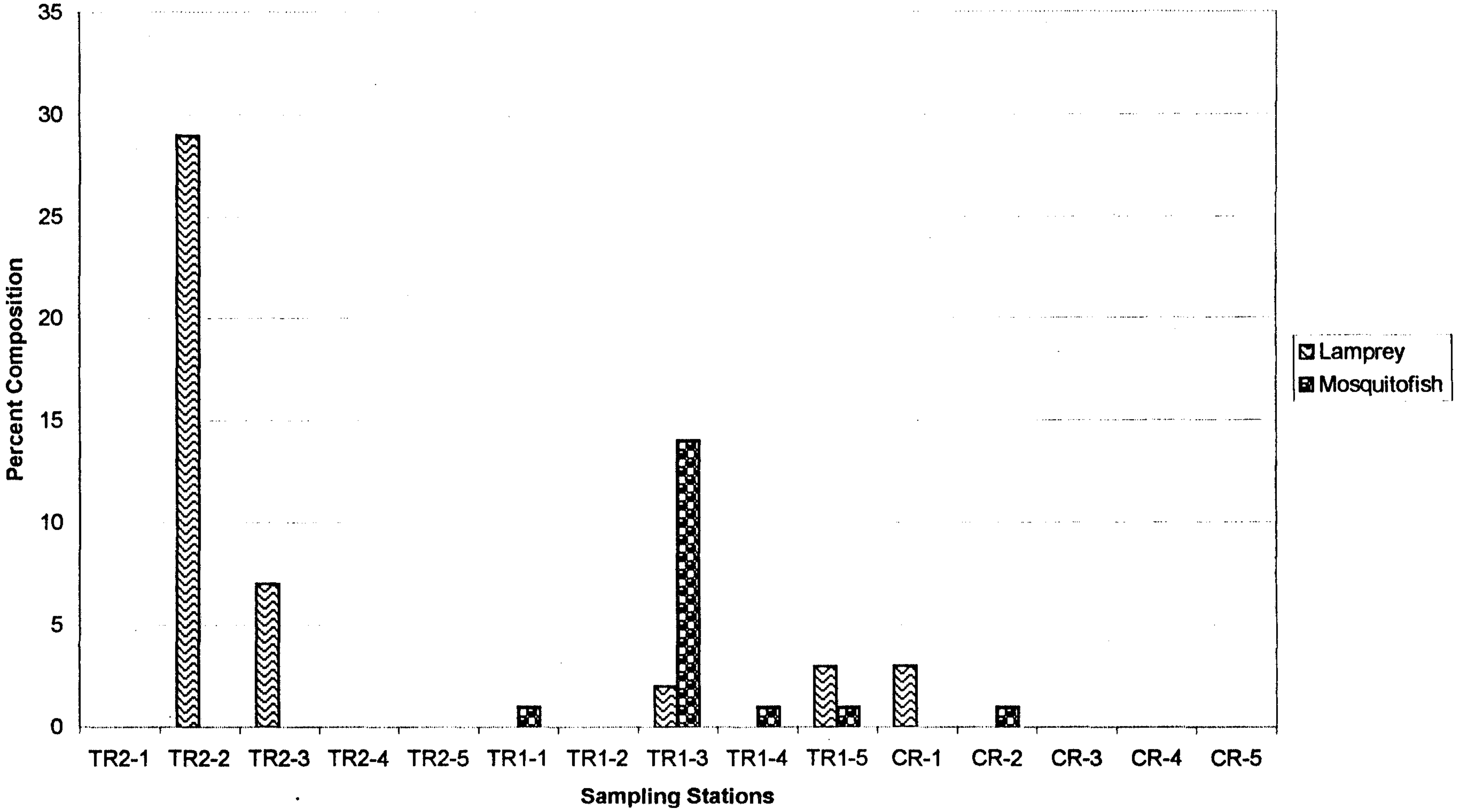


Figure 5
Coyote Creek Fish Composition, Lamprey and Mosquitofish, September 1998



4.0 CONCLUSIONS

The first objective of the Phase I fisheries monitoring program was to inventory the fisheries and benthic invertebrates of the flow augmentation treatment reach of Coyote Creek and an upstream control reach on the same creek. This was accomplished through the September 24 – October 3, 1998 sampling of five stations in each of the three study reaches for a total of 15 stations. While each sampling station was positioned to include riffle habitat, the ease with which each riffle's benthic invertebrate population could be sampled by kick net varied considerably. Several riffles were comprised of 5 to 8-inch cobbles that were difficult to kick loose from the bottom. However, the paucity of riffle habitat within the study area of Coyote Creek doesn't allow the selection of sampling stations based on similar riffle substrate size.

Overall, the aquatic invertebrate data suggests an ecologically disturbed aquatic system with little or no uniformity between sampling stations. The study area is dominated by ecologically tolerant invertebrate species. The greatest densities and productivity appear at the extreme downstream end (TR2-1) and in the control reach where there is a greater amount of cobble and gravel riffles.

The fish habitats sampled by backpack electrofisher were limited to those with depths of less than 4 feet at flows of 3 to5 cfs. One station (CR-4) includes a pool habitat too deep for electrofishing and was sampled using a 6-foot deep seine. Seining was found to be adequate for qualitatively inventorying fish species occurring in the moderate-depth pool habitats. However, the stream pool habitat typically includes enough snags along the shoreline and mid-stream to render seining inadequate for attempting a multiple pass depletion approach to quantifying fish numbers. Having just one station with a habitat type not sampled in other stations (the moderate-depth pool habitat sampled by seining) may bias the similarity comparisons between stations. An additional concern is that by excluding the deeper pools from the monitoring effort, the fisheries program will be unable to assess the Pilot Project's effect on the fish assemblages favoring this relatively common habitat occurring throughout the study area. Although pool habitats typically show the least change in current velocity and depth in response to flow increases, the deeper pool habitats of Coyote Creek likely become critically important to the fisheries during dry water years when there is a cessation of surface flow in portions of the creek. Limitations to the seining technique and having only one station with moderate-depth habitat sampled creates problems that should be resolved before initiation of the Phase II effort.

The second objective of the Phase I effort was to determine the similarity or differences between the biota of the treatment reaches and the Control Reach. A visual comparison of the percent composition by fish family shows a predominance of minnow species in the TR1 reach (see Figure 2) and a predominance of sunfish species in the Control Reach (see Figure 3). Analyzed using a chi-square test, the statistical analysis of these data strongly rejected the null hypothesis of no differences between fish populations by family between the treatment and control reaches.

The third objective of the Phase I effort was to develop a pre-project index of juvenile steelhead and other summer resident fish in the treatment and control reaches. As noted above, the field sampling established the species composition and relative numbers of the non-salmonid fishes. However, no steelhead were found in the study area, although one adult chinook salmon was observed migrating upstream in Coyote Creek by Montague Expressway (Treatment Reach 2). These findings indicate there were no, or very few, juvenile steelhead using the study area as rearing habitat during this period of higher summer flows than usual. At this time, the pre-project index of juvenile steelhead numbers is zero.

5.0 PHASE II RECOMMENDATIONS

In Phase II, the fish inventory data should be evaluated relative to data on stream flow, water temperature, and habitat characteristics. Habitat mapping should include an assessment of the abundance of tree roots along the stream bank. Stream banks with extensive tree roots were observed in the field to support substantially more fish than stream banks with few or no tree roots.

The statistical analysis for Phase II will focus on whether the distributions and abundance of fish biota change due to the flow augmentation. This analysis will extend the chi-square test used in Phase I to include year of collection. A log-linear model should be constructed which tests for a significant interaction between year of collection and the relationship between family counts and reach. If the null hypothesis of no difference between pre- and post flow augmentation is rejected, the direction and magnitude of these differences can be estimated through odds-ratios, contingency tables, and graphs.

However, the lack of similarity between the predominant fishes of the treatment reaches and those of the control reach makes it unlikely that the proposed analysis will be able to distinguish between subtle effects due to "natural" conditions and effects due to flow augmentation during a given year. Differences in habitat preferences (current velocity, water depth, temperature, and cover) and prey items between the minnow family species versus that of the sunfish family species make the present designated control reach of less value than intended by the study design.

The control reach could, however, still be useful for evaluating perceived shifts in the numbers of largemouth bass, smallmouth bass, and green sunfish in the treatment reaches. Because the fishes most likely to prey on juvenile steelhead in the treatment reaches are largemouth and smallmouth bass, these two species in particular should be closely monitored. The numbers and size frequency of bass in the control reach can be compared with population trends for these species in the treatment reaches. For this reason, it is recommended that the existing control reach monitoring be continued.

Additionally, it is recommended that the fish sampling results for the Guadalupe River be reviewed to determine the location of a 3 to 5 mile section of that river that is predominantly California Roach and hitch. Should a portion of the Guadalupe River have habitat conditions and fish composition relatively similar to that of Treatment Reach 1 in Coyote Creek, it could be used as a control reach to document comparable conditions outside the treatment reach.

The habitats sampled at the 15 stations along Coyote Creek include only one deep pool. To avoid skewing the data for that station, it is recommended that either the deep pool habitat from Station CR-4 be excluded or that deep pool habitat be added to a station in each of the two treatment reaches. This had been the intent of the original site selection process, but attempts to effectively seine the deep pool at CR-4 were sufficiently unsatisfactory that sampling the deep pools in the treatment reach stations was dropped from the field effort.

A more effective sampling technique in the deep pool habitat might be a trap net with a 100 foot lead net. The trap net, consisting of metal frames and hoops covered with 0.5-inch square mesh netting, is set facing downstream in the upper corner of a pool. A 100-foot lead net of similar mesh size floats 4 feet off the bottom and extends diagonally down and across the pool. Overnight sets of this type of trap net have proven very effective at capturing a variety of fish in rivers, lakes, and tidal sloughs. Several trap net sets should be tried in Coyote Creek to determine their effectiveness.

Another reason for determining the effectiveness of trap nets is because many of the 1998 sampling stations contained habitat that was waist deep at a flow of 3 to 5 cfs. Augmented flows could raise the water level to a degree that prohibits electrofishing portions of the established sampling stations. Hopefully, air and water temperature conditions will permit the lowering of stream flow in the treatment reach to 3 cfs for two weeks of sampling in late September or early October during the following years.

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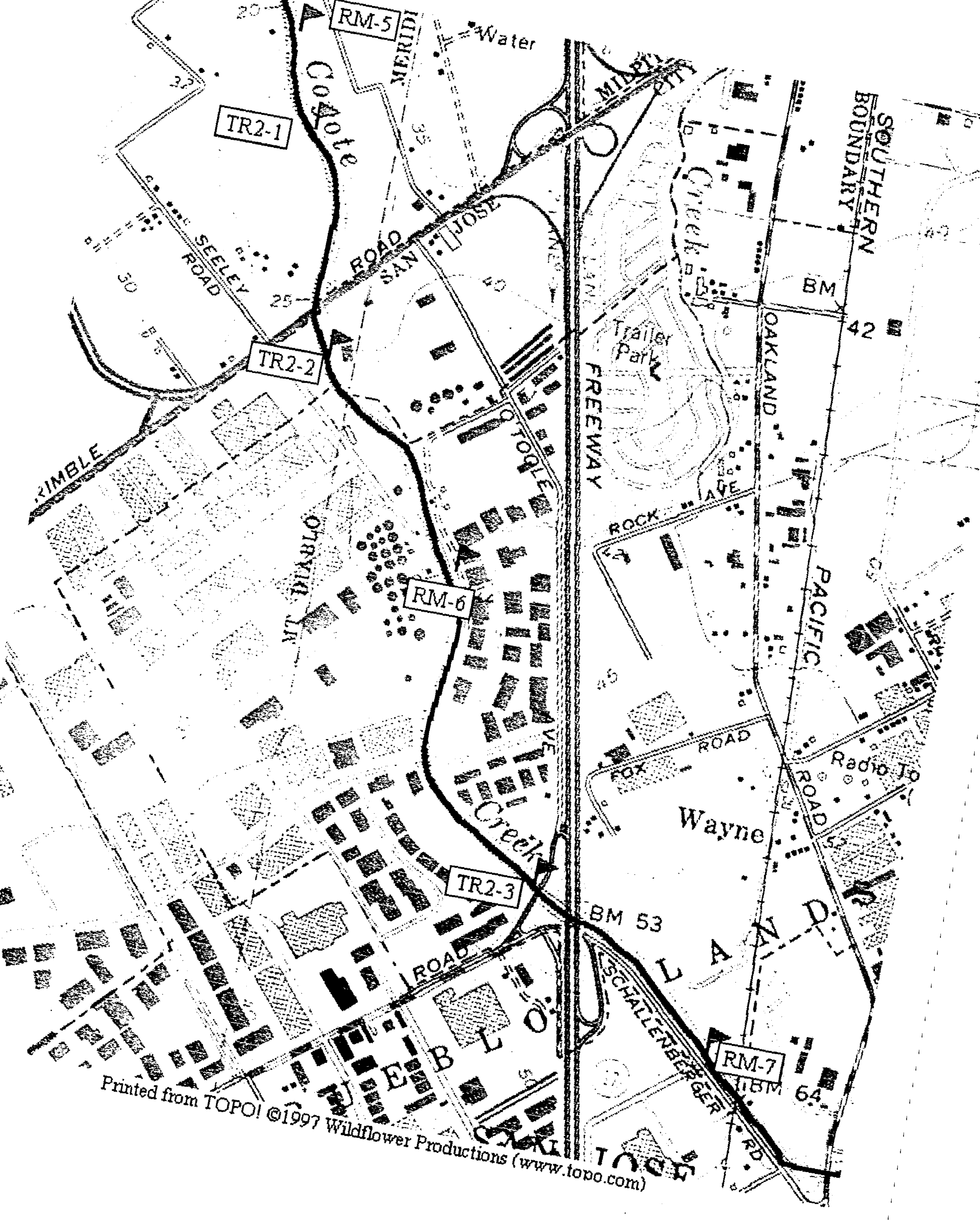
APPENDIX A

Detailed Maps Showing Coyote Creek Phase I Fish Sampling Stations, 1998



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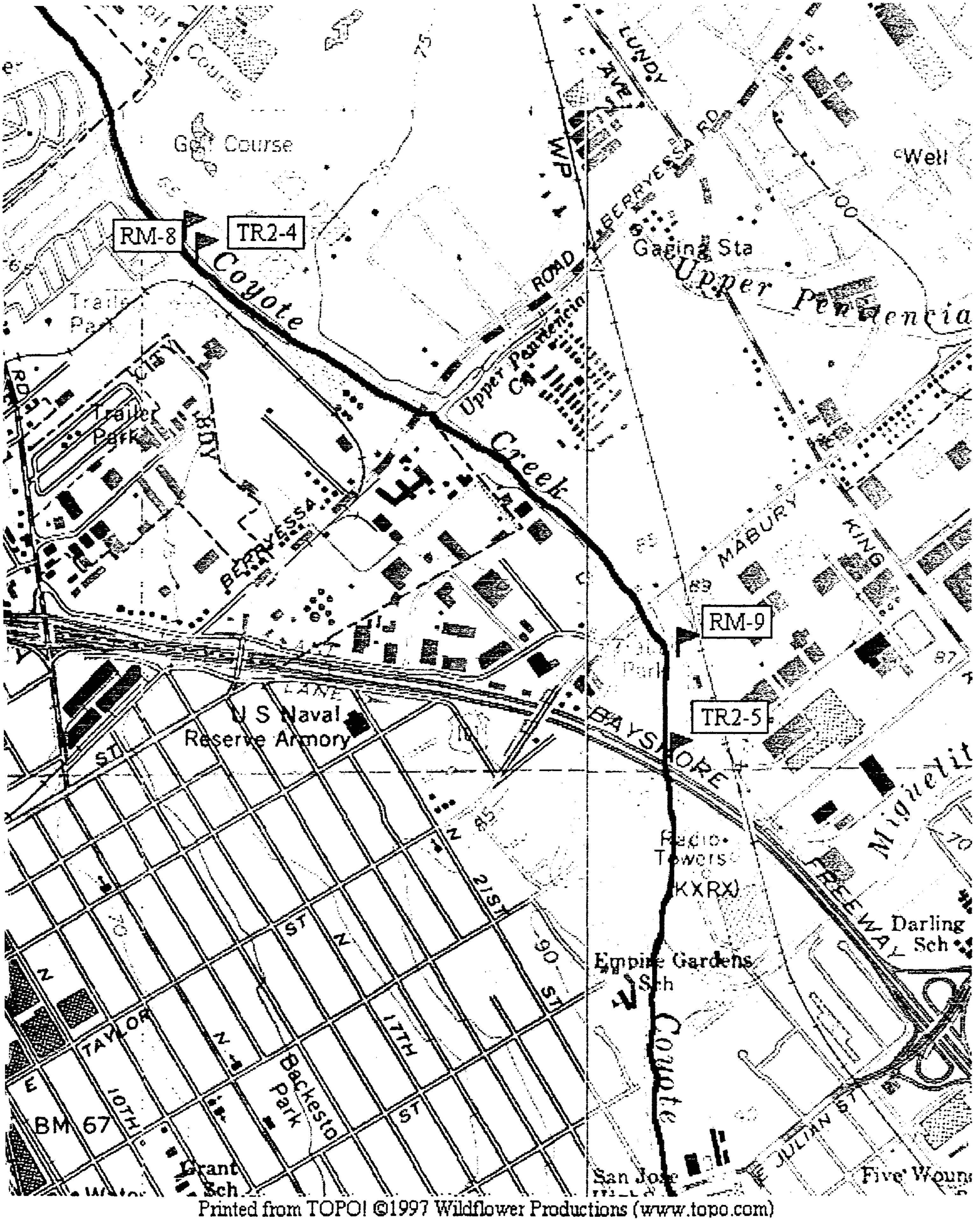

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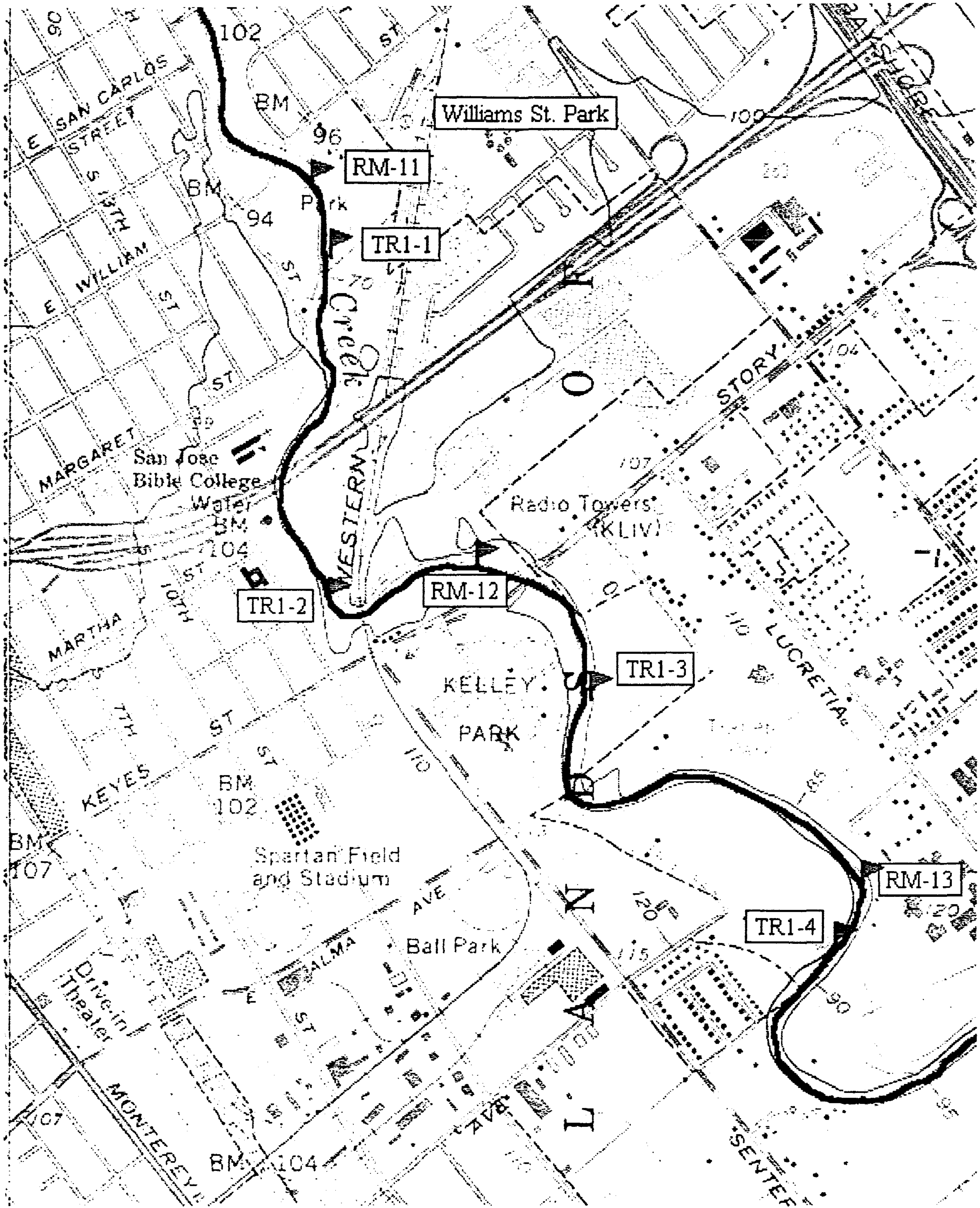

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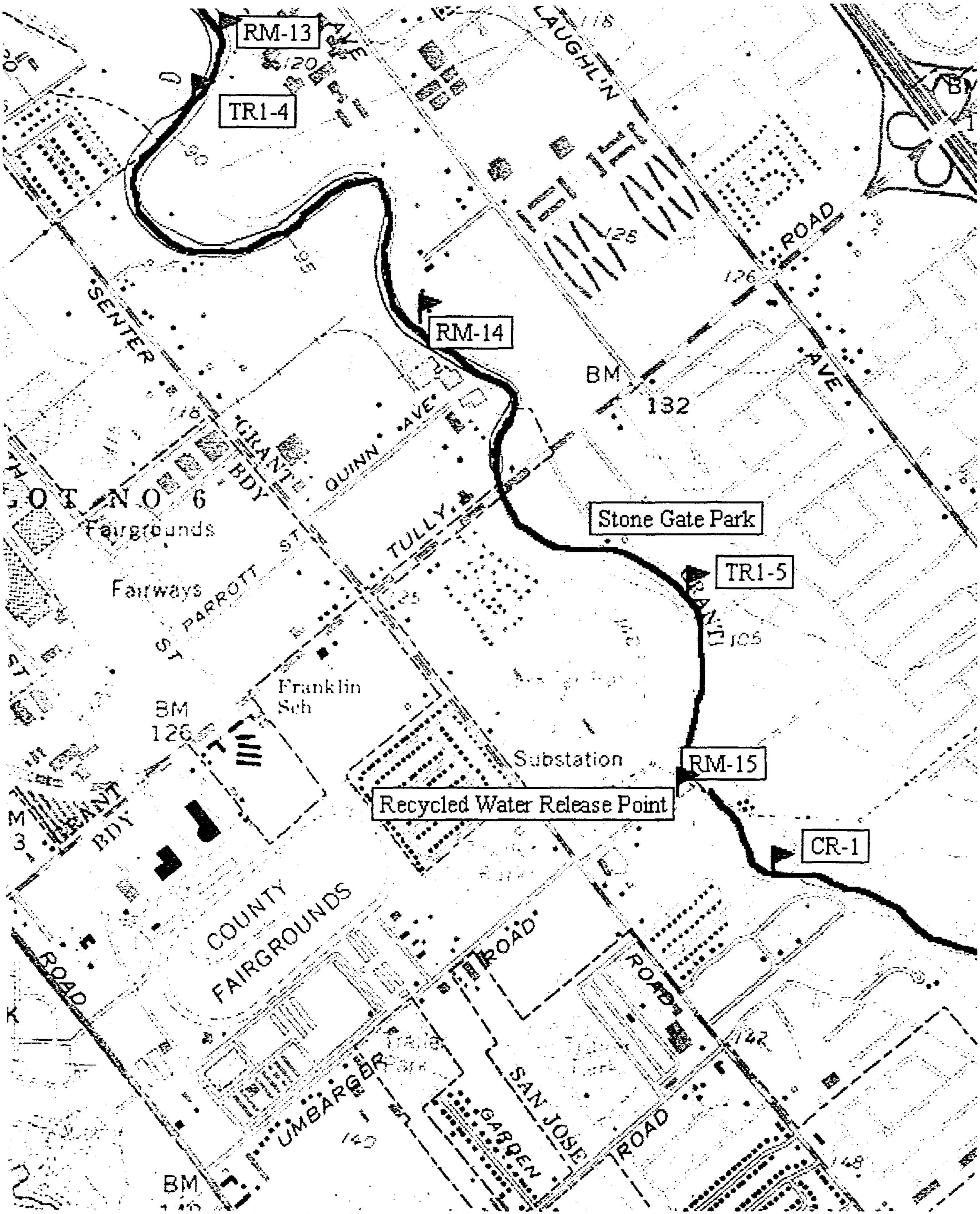

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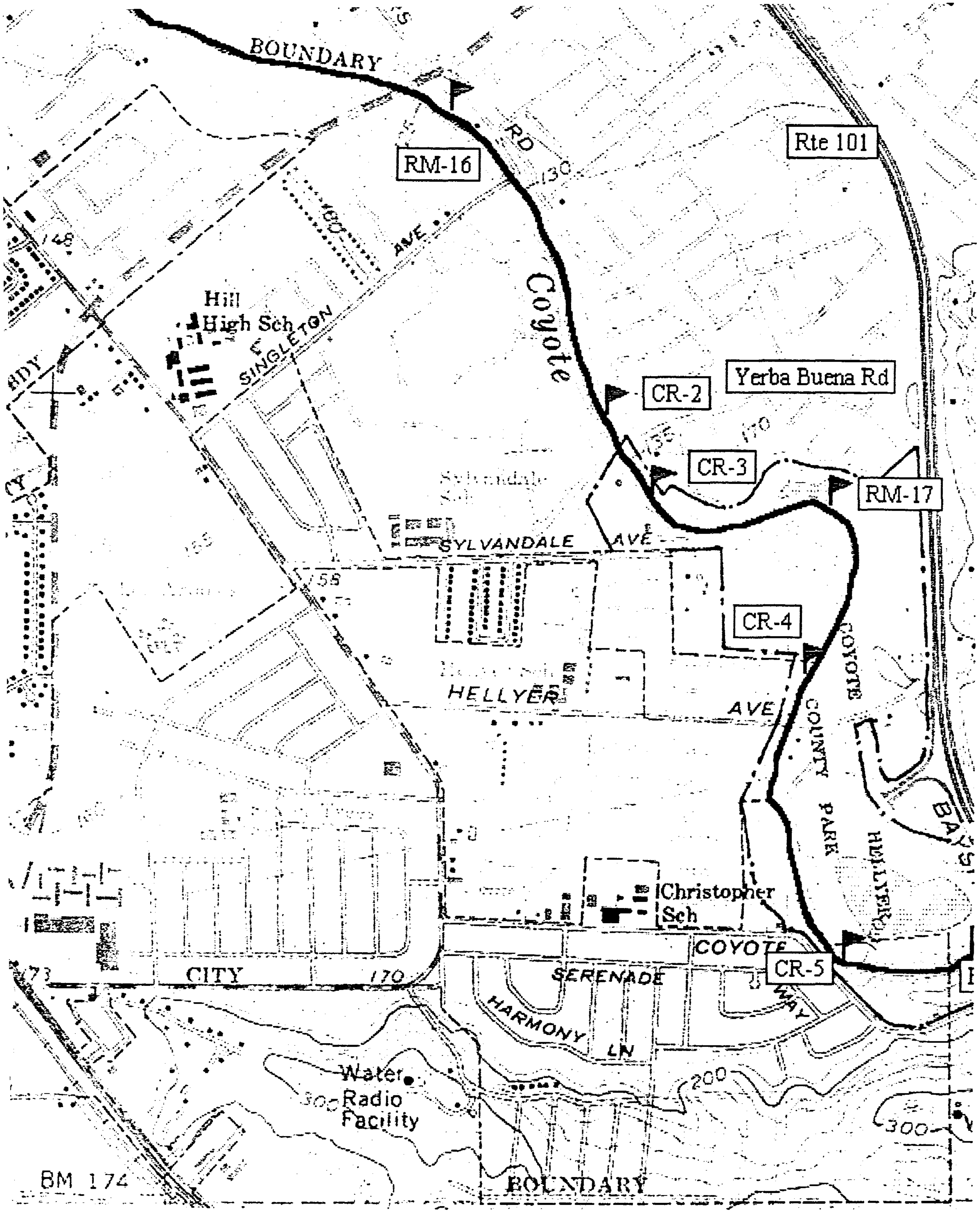

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APPENDIX B

Aquatic Macroinvertebrate Report by Jones & Stokes Associates

DATE: November 13, 1998

TO: Don Arnold /City of San Jose
Tom Grieb and Tetra Tech Team
Barry Scott/KCM Team
Chuck Hanson

FROM: Doug Brewer and the Jones & Stokes Associates' Fisheries Team

SUBJECT: Coyote Creek Reconnaissance Fisheries Habitat Survey

On November 2-3, 1998, fishery biologist Dr. Beth Campbell and hydrologist Simon Page conducted fieldwork on Coyote Creek (Santa Clara County) for the City of San Jose's Streamflow Augmentation Pilot Study. Streamflow augmentation in Coyote Creek is scheduled to begin in July 1999, and is intended to provide better habitat for cool-water fishes such as chinook salmon and steelhead. The purpose of this reconnaissance survey work was to collect baseline fish habitat data (i.e., before flow augmentation) for the autumn season at selected study sites. These sites will be used to monitor and evaluate changes in fish habitat resulting from streamflow augmentation in subsequent years. Based on recent fish surveys conducted by LSA for the City of San Jose, Coyote Creek is dominated by pool habitat and warmwater fish fauna that includes native hitch, California roach, and Sacramento sucker, as well as introduced black bass and other sunfishes. No salmonid species were observed during the LSA surveys based on a review of their field notes. The largemouth bass, smallmouth bass and green sunfish observed are potential predators of larval and juvenile salmonids. During our 2-day survey, we observed several neighborhood children who had successfully caught sunfishes while fishing in deep pools. This information suggests a fairly abundant population of sunfish.

The field crew established 3-5 transects at each of four sampling stations in Coyote Creek (Table 1; Figure 1). The proposed study boundaries are Capitol Expressway to the southwest and downstream to the mouth of Coyote Creek to the northeast (i.e., approximately 16 miles). Treatment (T1 and T2) and control (C1 and C2) sampling stations were established downstream and upstream, respectively, of the proposed site of augmentation flow release downstream of the Capitol Expressway (Figure 1). Figures 2 and 3 provide photographs of the control and treatment sites. Photographs were taken of all transects and of the entire sampling station. Transects were selected to provide a diversity of habitat types (e.g., pools, tails of pools, low and high gradient riffles, runs, etc.), and sampling stations were located in areas that had at least one pool, riffle, and run in close proximity.

Jones & Stokes Associates, Inc.
2600 V Street. Suite 100 • Sacramento, CA 95818-1914 • Fax 916/737-3030 • 916/737-3000

At each sampling station, water quality was assessed and recorded by measuring water temperature, dissolved oxygen (DO) level, and electrical conductivity (EC) using a Yellow Springs Instruments Model 33 (EC and temperature) and Model 57 (DO) field meter (our field notes are included in Attachment A). The water quality meters were calibrated in the Jones & Stokes Associates' laboratory before use in the field. Surveying equipment was used to determine the stream channel profile and water surface level at each transect. Also, water depth and velocity were measured at regular locations along the transect with a depth rod and Marsh McBirney Model 201flow meter. These data will be used later in the monitoring study to determine wetted habitat area and water depth and velocity characteristics under different flow regimes using habitat and hydraulic modeling procedures of the Instream Flow Incremental Methodology (IFIM). Four other critical fish habitat characteristics (i.e., cover, substrate type, substrate embeddedness, and shade) also were assessed by the fishery biologist along the transects. These characteristics will be reassessed throughout the study period.

Jones & Stokes Associates will be implementing the second phase of instream habitat survey for the lower reaches of Coyote Creek to collect habitat data to ensure that will be used to assess the effects of flow augmentation on fish habitat. We propose to briefly survey Coyote Creek from Capitol Expressway to the mouth using the same techniques implemented by Chuck Hanson and the FAHCE study team. During the survey, two to three fisheries biologists will walk or use a small boat to survey and map the entire reach of Coyote Creek downstream of Capitol Expressway to (1) identify potential barriers to passage of adult steelhead and chinook salmon, and (2) map the available fish habitat. We envision using GPS technology to accurately map the potential fish barriers. We anticipate that the survey will require 3-4 days and are scheduling the field work for the week of November 16, 1998.

cc: Alan Solbert
Tom Cannon
Beth Campbell

Table 1. Location of Fish Habitat Sampling Stations and Number of Transects Established on Coyote Creek (Santa Clara County) on November 2-3, 1998.

Sampling Station	Date	Location	Distance from Proposed Inflow	Number of Transects
T1	November 2, 1998	Near La Ragione Avenue	0.4 miles downstream	3
T2	November 2, 1998	Near Wool Creek Drive	1.0 miles downstream	5
C1	November 3, 1998	Near Balfour Drive	0.2 miles upstream	4
C2	November 3, 1998	Near Dakota Drive	0.6 miles upstream	4

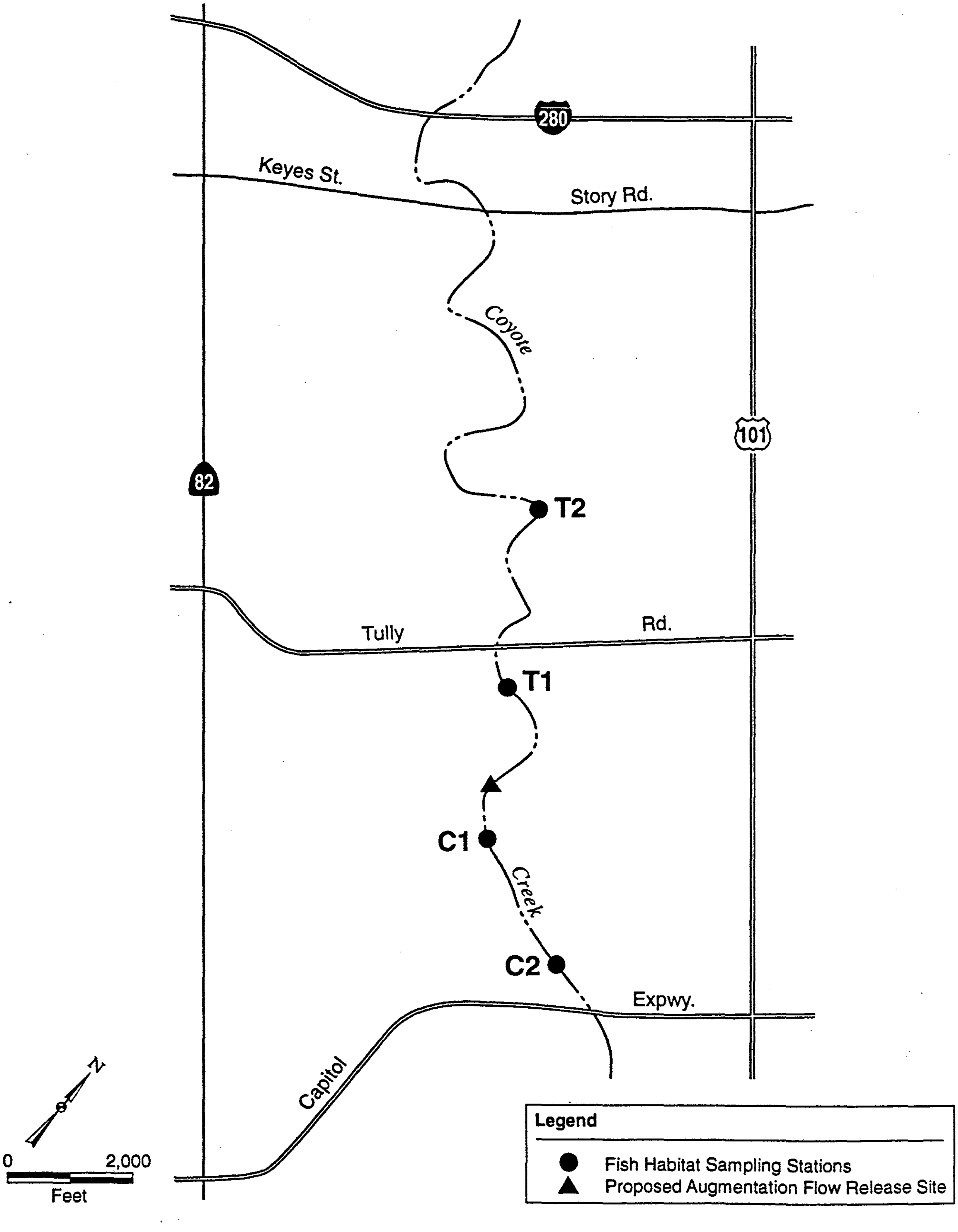

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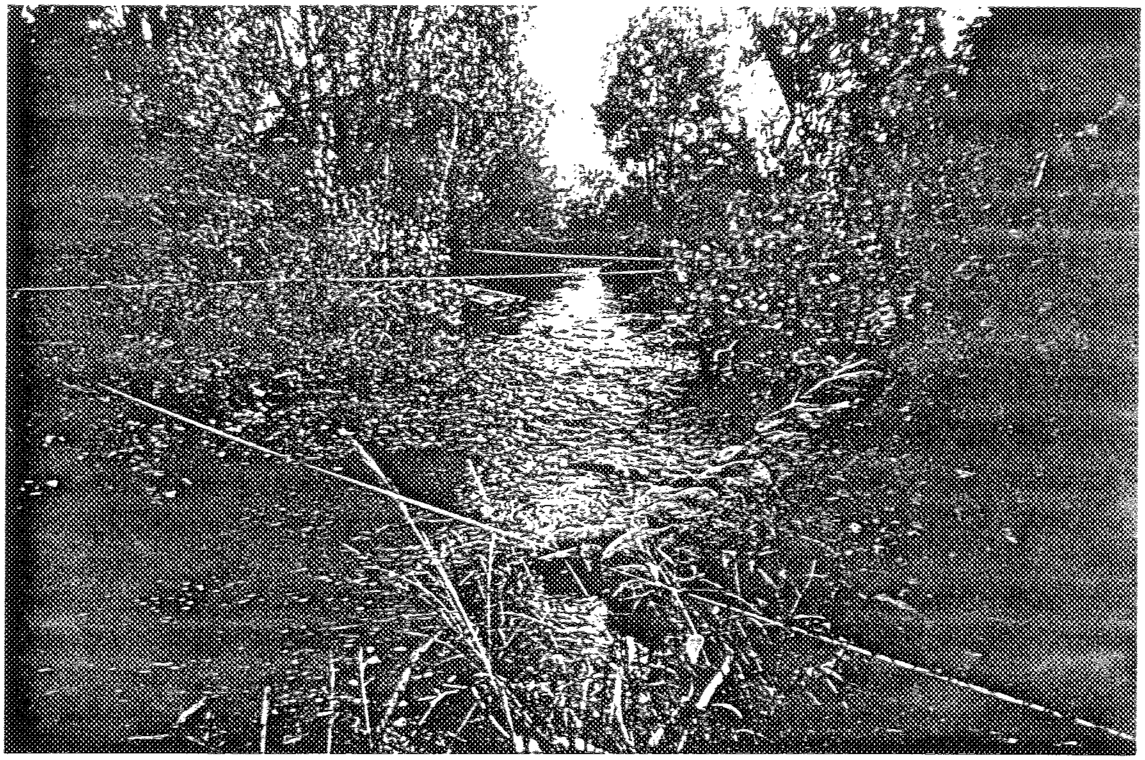
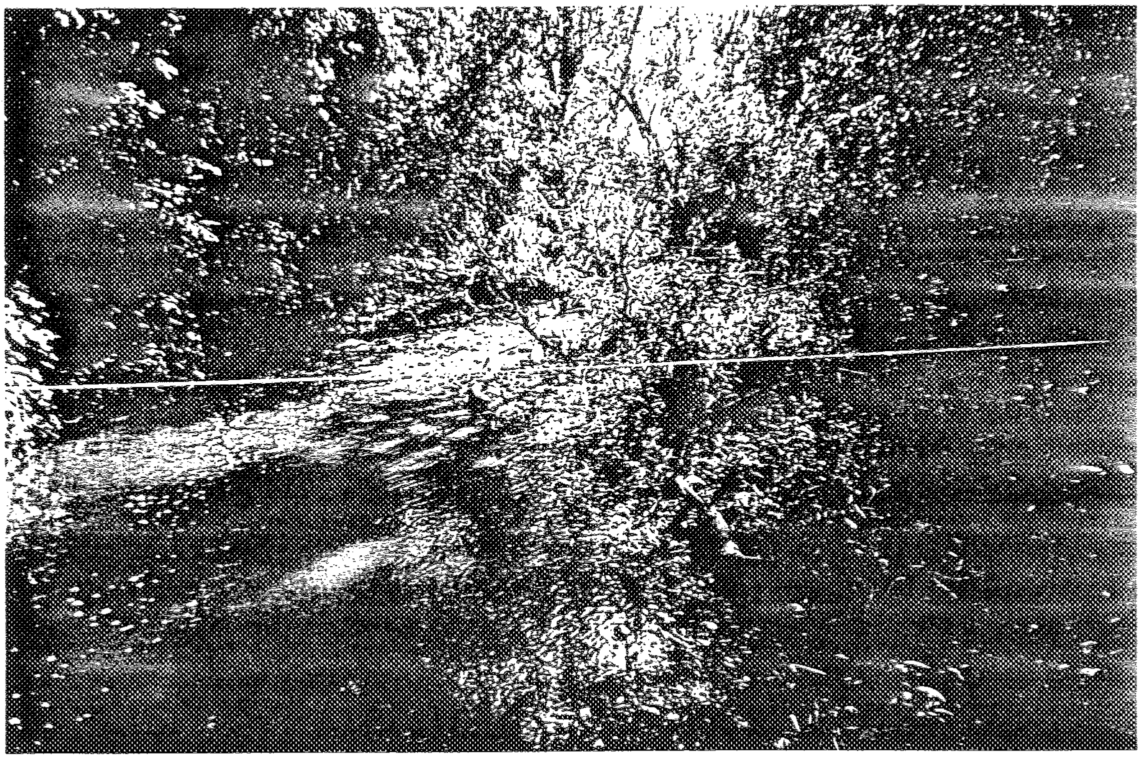
Figure 1
Location of Fish Habitat Sampling Stations
Established on Coyote Creek (Santa Clara County)
on November 2-3, 1998

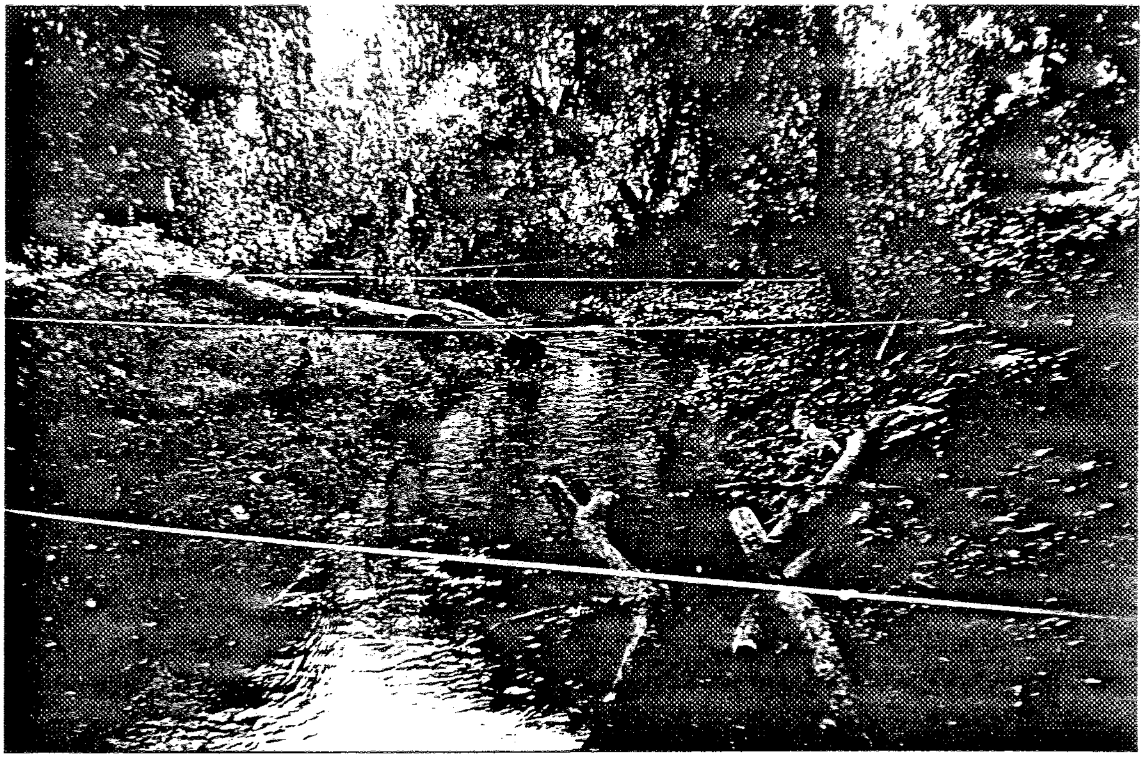


Photograph 1. Treatment sampling station T1 (looking upstream)

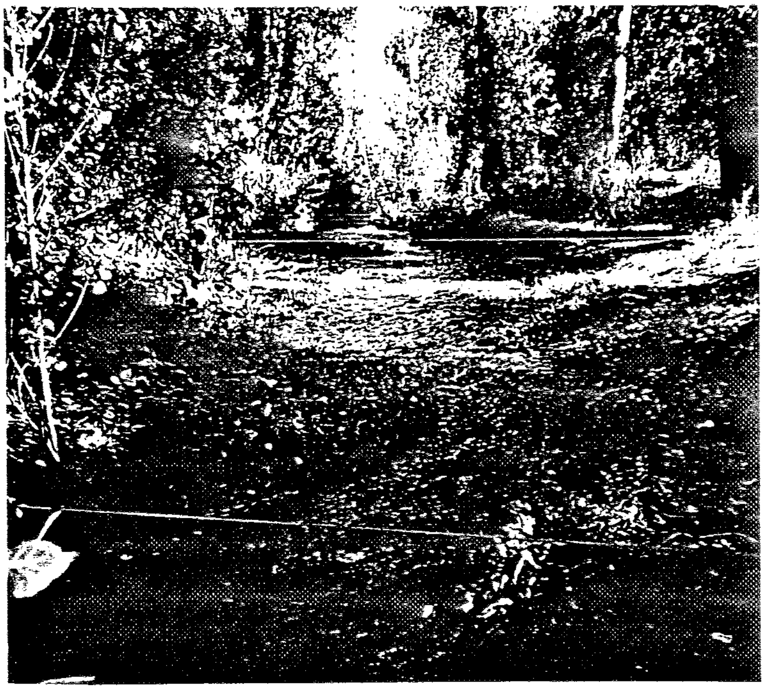


Photograph 2. Treatment sampling station T2 (looking upstream)

Figure 2
Treatment Sampling Stations T1 and T2 on Coyote Creek



Photograph 1. Control sampling station C1 (looking upstream)



Photograph 2. Control sampling station C2 (looking upstream)

Figure 3
Control Sampling Stations C1 and C2
on Coyote Creek

Transect No. 12 Segment No. 1 Unit No. 134h

Backsight to Benchmark: 6.01
Height of Instrument:______
FS to Stage Zero Flow:______
SZF:______
WS Slope: (FS1-FS2)/Distance
WS Slope:(_____ - _____)/_____
BS to Benchmark: 6 01

Distance from LB Head Pin	Foresight	Cover					Substrate	
		A	W	S	B	O		
0.0	5.40					X	2/1	70
2	5.58		X			X	↓	↓
4	6.28		X			X	↓	↓
6	6.93		X			X	9/2	60
8	7.12		X			X	↓	↓
10	7.14	X	X			X	↓	↓
12	7.58	X		X	X	X	↓	↓
14	8.52	X				X	9/5	60
16	8.69	X				X	↓	↓
18	8.73					X	↓	↓
20	8.80					X	↓	↓
22	8.74						↓	↓
24	8.53	X	X				5/8	70
26	7.67	X	X			X	2/1	70
28	6.59	X				X	↓	90
29.5	5.90	X	X			X	↓	↓
27	7.54							
29	6.52							
29.5	5.90							

Benchmark Location:

Low Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 6.01 HI:______
FS to LWSEL: 7.88 LWSEL:______
FS to RWSEL: 7.88 RWSEL:______
Average WSEL:______
BS to Benchmark: 6 01

Medium Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

Cover Code

A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

undercut

Substrate Code

1: organic debris	8: Coarse gravel 2-3
2: mud, soft clay	9: small cobble 3-6
3: silt <.002	10: med cobble 6-9
4: fine sand .002-.1	11: large cobble 9-12
5: coarse sand .1-.25	12: small boulder 12-24
6: fine gravel .25-1	13: large boulder >24
7: med gravel 1-2	14: bedrock

Dominant Subdominant . Percent Dominant

11-2-98
1530
Temp = 14°C
O^2: 10.2mg/L
Conductivity 460 umhos

% embedded 60%

% shade at noon 100%

Transect No. T1 Segment No. 2 Unit No. [illegible]

11-2-93

Backsight to Benchmark: 6.01
Height of Instrument:______
FS to Stage Zero Flow:______
SZF:______
WS Slope: (FS1-FS2)/Distance
WS Slope:(_____ - _____)/_____
BS to Benchmark: 6.01

Benchmark Location:

Distance from LB Head Pin	Foresight	Cover					Substrate	
		A	W	S	B	O		
0.0	6.01						2/1	60
2	6.18							
4	6.44							
6	6.52					X		
8	6.75					X		
10	6.77						8/7	60
12	6.45	X						
14	6.30	X						
16	6.43	X						
18	6.75	X				X	8/1	
20	7.09	X				X		
22	7.60	X				X	9/1	
24	7.88	X	X			X		
26	8.41		X					
28	8.52						8/5	
30	8.52						9/5	
32	8.51							
34	8.61					X		
36	8.61		X		X	X		
38	7.49		X				8/1	60
40	7.42		X				2/1	60
42	7.11		X				2/1	60
44	6.25		X					80
46	4.21		X					
45	4.59							

Low Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 6.01 HI:______
FS to LWSEL: 8.70 LWSEL:______
FS to RWSEL: 8.21 RWSEL:______
Average WSEL:______
BS to Benchmark: 6.01

Medium Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

% embeddedn
40%

Cover Code
A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

Substrate Code

1: organic debris	8: Coarse gravel 2-3
2: mud, soft clay	9: small cobble 3-6
3: silt <.002	10: med cobble 6-9
4: fine sand .002-.1	11: large cobble 9-12
5: coarse sand .1-.25	12: small boulder 12-24
6: fine gravel .25-1	13: large boulder >24
7: med gravel 1-2	14: bedrock

Dominant Subdominant . Percent Dominant

% shad
at noon
50%

Transect No. TZ1 Segment No. 3 Unit No. Pool (near head)

11-2-98

Backsight to Benchmark: 6.01
Height of Instrument:______
FS to Stage Zero Flow:______
SZF:______
WS Slope: (FS1-FS2)/Distance
WS Slope:(_____ - _____)/_____
BS to Benchmark: 6.01

Benchmark Location:

Distance from LB Head Pin	Foresight	Cover					Substrate	
		A	W	S	B	O		
0.0	6.01						2/1	60
2	6.18						↓	↓
4	6.38						4/1	70
6	6.50					X		
8	6.78					X		
10	7.20					X	↓	
12	7.58						2/1	
14	7.90					X		
16	7.91					X		
18	7.87					X	↓	↓
20	7.61					X	2/7	60
22	7.48	X					↓	
24	7.45	X					8/2	
26	7.61	X	X			X	↓	↓
28	8.21		X			X	5/7	60
30	8.99					X		
32	9.54					X	↓	
34	10.21						5/8	
36	10.55							
38	10.62						↓	
40	10.59							↓
42	10.41		X				5/7	70
44	10.12		X			X		
46	9.34		X			X		
48	8.44		X			X		
50	7.52		X			X	↓	↓
52	7.10						5/8	60
53	6.69						↓	↓

Low Flow
Date: 11/2/98
Crew: DL / SP
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 6.01 HI:______
FS to LWSEL: 8.69 LWSEL:______
FS to RWSEL: 8.69 RWSEL:______
Average WSEL:______
BS to Benchmark:______

Medium Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

% embeddedne
40%

% shade at noon
60%

Cover Code
A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

Substrate Code

1: organic debris	8: Coarse gravel 2-3
2: mud, soft clay	9: small cobble 3-6
3: silt <.002	10: med cobble 6-9
4: fine sand .002-.1	11: large cobble 9-12
5: coarse sand .1-.25	12: small boulder 12-24
6: fine gravel .25-1	13: large boulder >24
7: med gravel 1-2	14: bedrock

Dominant Subdominant . Percent Dominant

Transect No. T2 Segment No. 1 Unit ~~No.~~ RUN

Channel Main ✓ Dominant ___ Subominant ___ Spawning ___	Date: 11/7/98 Crew: BL/SP Gage Start: Depth____ Time____ Gage Finish: Depth____ Time____ Meter Calibration: S__ F__ Photo: 7	Date: Crew: Gage Start: Depth____ Time____ Gage Finish: Depth____ Time____ Meter Calibration: S__ F__ Photo:	Date: Crew: Gage Start: Depth____ Time____ Gage Finish: Depth____ Time____ Meter Calibration: S__ F__ Photo:

Distance from LB Head Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
12	WE	0		0									
13		.4		0									
14		.6		0									
16		.8		0									
17		.8		.3									
18		.8		.9									
19		.8		1.6									
20		1.0		1.1									
21		1.0		.9									
22		.9		1.2									
23		.8		.9									
24		.6		.2									
25		.3		0									
25.5		0		0									

Notes:

Transect No. T1 Segment No. 2 Unit No. RIFFLE

Channel			
ain ✓ ominant___ ıbominant___ ıawning___	Date: 2/11/98 Crew: BG SP Gage Start: Depth_____ Time_____ Gage Finish: Depth_____ Time_____ Meter Calibration: S__ F__ Photo: 8	Date: Crew: Gage Start: Depth_____ Time_____ Gage Finish: Depth_____ Time_____ Meter Calibration: S__ F__ Photo:	Date: Crew: Gage Start: Depth_____ Time_____ Gage Finish: Depth_____ Time_____ Meter Calibration: S__ F__ Photo:

ɔistance ɾom LB Head Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
25	WE	0		0									
26	DRY												
27		.2		1.2									
28		.2		2.6									
29		.3		2.2									
30		.3		2.0									
31		.3		1.7									
32		.3		2.9									
33		.3		2.4									
34		.4		2.1									
35		.3		1.9									
36		.3		0									
36.9	WE	0		0									

Notes:

Transect No. 1 Segment No. 3 Unit No. POOL

Channel			
lain ✓	Date: 11/2/98	Date:	Date:
ominant___	Crew: BC/SP	Crew:	Crew:
ubominant___	Gage Start: Depth____ Time____	Gage Start: Depth____ Time____	Gage Start: Depth____ Time____
pawning___	Gage Finish: Depth____ Time____	Gage Finish: Depth____ Time____	Gage Finish: Depth____ Time____
	Meter Calibration: S__ F__	Meter Calibration: S__ F__	Meter Calibration: S__ F__
	Photo: 9, 10 US	Photo:	Photo:

Distance from LB Head Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
28	WE	0		0									
29		.2		0									
30		.2		0									
32		.8		0									
34		1.4		0									
36		1.7		.4									
38		1.9		1.4									
40		1.9		.3									
42		1.8		0									
44		1.3		0									
46		.8		0									
47.5	WE	0		0									

Notes:

Coyote Creek @ [illegible] Creek

Transect No. T3/2 Segment No. 1 Unit No. Pool

11-2-98

@ 1120;

14°C

8.5 mg/l

0°

470 umhs

Backsight to Benchmark: 4.61
Height of Instrument:______
FS to Stage Zero Flow: 6.72
SZF:______
WS Slope: (FS1-FS2)/Distance
WS Slope:(6.02 - 6.02)/_____
BS to Benchmark: 4.61

Benchmark Location:

Distance from LB Head Pin	Foresight	Cover A	Cover W	Cover S	Cover B	Cover O	Substrate	
0.0	3.46		X				[illegible]	2/1
2.0	4.49		X				2/1	
4.0	5.74		X				2/1	
6.0	8.08		X		X		2/1	70%
8.0	8.59		X		X		3/1	
10.0	9.10		X				3/1	
12.0	9.10		X				3/1	
14.0	9.12		X			X	3/1	
16.0	9.00		X			X	3/8	50%
18.0	8.85		X			X	3/8	50%
20.0	8.78		X			X	7/3	50%
22	8.32		X			X	3/1	70%
24	7.77		X			X	2/1	70
26	7.09		X		X	X	2/1	50
28	5.59		X			X	2/1	
30	5.21		X			X	2/1	
32	4.84		X				2/1	
35.5	4.78		X				2/1	
22	5.24							

1 on
ft
bank

Low Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 4.61 HI:______
FS to LWSEL: 6.02 LWSEL:______
FS to RWSEL: 6.02 RWSEL:______
Average WSEL:______
BS to Benchmark: 4.61

Medium Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

% embedded
70%

% Shade at noon;
80%

Cover Code
A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

Substrate Code

1: organic debris	8: Coarse gravel 2-3
2: mud, soft clay	9: small cobble 3-6
3: silt <.002	10: med cobble 6-9
4: fine sand .002-.1	11: large cobble 9-12
5: coarse sand .1-.25	12: small boulder 12-24
6: fine gravel .25-1	13: large boulder >24
7: med gravel 1-2	14: bedrock

Dominant Subdominant . Percent Dominant

Left bank looking upstream.

Segments (Transects) counted us(1) to ds(5)

Transect No. T2 Segment No. 2 Unit No. Pool-tail

11-2-98

Backsight to Benchmark: 4.61
Height of Instrument:______
FS to Stage Zero Flow: 6.49
SZF:______
WS Slope: (FS1-FS2)/Distance
WS Slope: (6.07 - 6.02)/______
BS to Benchmark: 4.61

Distance from LB Head Pin	Foresight	Cover					Substrate	
		A	W	S	B	O		
0.0	4.12						2/1	60%
2.0	4.40						2/1	
4	4.84						2/1	
6	5.33					<	2/1	↓
8	6.09						8/2	50%
10	6.12						9/6	70%
12	6.31							70%
14	6.51							
16	6.72							
18	6.70							
20	6.55							
22	6.49						↓	↓
24	6.34						8/9	60%
26	5.82	X						
28	5.34	X						
30	5.09	X						
32	4.77							
34	4.62							
36	4.51							
38	4.38		X				↓	↓
40	3.89		X				7/1	60%
42	3.75		X				7/1	↓
42.5	3.71							
7	5.82							

Benchmark Location:

Low Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 4.61 HI:______
FS to LWSEL: 6.02 LWSEL:______
FS to RWSEL: 6.02 RWSEL:______
Average WSEL:______
BS to Benchmark: 4.61

Medium Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

% emb,
40%

Cover Code	
A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd	
Substrate Code	
1: organic debris	8: Coarse gravel 2-3
2: mud, soft clay	9: small cobble 3-6
3: silt <.002	10: med cobble 6-9
4: fine sand .002-.1	11: large cobble 9-12
5: coarse sand .1-.25	12: small boulder 12-24
6: fine gravel .25-1	13: large boulder >24
7: med gravel 1-2	14: bedrock
Dominant Subdominant . Percent Dominant	

~~%~~ shade
at mo.
60%

[illegible]

Transect No. T32 Segment No. 3 Unit No. Run Photo #3

11-2-98

Backsight to Benchmark: 4.61
Height of Instrument:______
FS to Stage Zero Flow: 6.49
SZF:______
WS Slope: (FS1-FS2)/Distance
39 WS Slope: (6.31 - 6.02)/______
BS to Benchmark: 4.61

Distance from LB Head Pin	Foresight	Cover A	Cover W	Cover S	Cover B	Cover O	Substrate	
0.0	1.52		X			X	2/1	80
2	2.72						2/1	50
4	4.08					x	2/1	
6	5.07					X	2/1	
8	5.39	X					2/1	↓
10	5.55		X			x	1/8	80
12	5.37		X			x	9/1	50
14	5.86		X			X	9/1	↓
16	6.63					X	3/1	50
18	7.02						8/9	60
20	6.91							
22	6.64						↓	↓
24	6.49						9/8	50
26	6.19							
28	5.94	X					↓	↓
30	5.21	X					8/9	50
32	5.25	X						
34	5.00	X						
36	4.80	X						
38	4.54							
40	4.35							
42	4.21							
44	3.79					X		
46	3.49					X	↓	↓
47.5	3.39							
15	6.05							

Benchmark Location:

Low Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 4.61 HI:______
FS to LWSEL: 6.08 LWSEL:______
FS to RWSEL: 6.05 RWSEL:______
Average WSEL:______
BS to Benchmark: 4.61

Medium Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

% emb.:
50%

% shade at noon
70%

Cover Code

A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

Substrate Code

1: organic debris	8: Coarse gravel 2-3
2: mud, soft clay	9: small cobble 3-6
3: silt <.002	10: med cobble 6-9
4: fine sand .002-.1	11: large cobble 9-12
5: coarse sand .1-.25	12: small boulder 12-24
6: fine gravel .25-1	13: large boulder >24
7: med gravel 1-2	14: bedrock

Dominant Subdominant . Percent Dominant

22

Transect No. T/2 Segment No. 4 Unit No. Kittle

Backsight to Benchmark: 3.45
Height of Instrument: ______
FS to Stage Zero Flow: 5.30
SZF: ______
WS Slope: (FS1-FS2)/Distance
WS Slope: (5.47 - 4.83)/______
BS to Benchmark: 3.45

Distance from LB Head Pin	Foresight	A	W	S	B	O	Substrate	
0.0	1.85		X			X	2/1	70
2.0	3.60		X			X	2/1	↓
4	5.39				X		9/8	50
6	5.35				X			
8	4.95				X			
10	4.73		X		X			
12	4.60		X		X			
14	4.42		X		X			
16	4.68		X					
18	4.85							
20	4.89					X		
22	4.91							
24	5.02		X			X		
26	5.01		X			X		
28	5.11		X			X		
30	5.23		X			X		
32	5.28					X		
34	5.29							
36	5.19							
38	5.18							
40	5.17							
42	5.30					X		
44	5.20		X			X		
46	5.09		X			X		
48	5.14		X			X		
50	5.15		X			X		
52	5.15		X			X		
54	5.03		X			X		
56	4.88	X	X				7/2	50
58	4.78	X	X					
60	4.73	X	X					
62	4.62	X	X					
64	4.60	X	X					
66	4.21	X				X		
68	4.70	X	X			X		
70	3.82	X	X			X		
72	3.39	X	X			X		
74	2.90	X	X			X		
76	2.83	X	X			X		
77	2.15							

Benchmark Location:

Low Flow
Date:
Crew:
Gage Start: Depth______ Time______
Gage Finish: Depth______ Time______
BS to Benchmark: 3.45 HI:______
FS to LWSEL: 4.91 LWSEL:______
FS to RWSEL: 5.01 RWSEL:______
Average WSEL:______
BS to Benchmark: 3.45

Medium Flow
Date:
Crew:
Gage Start: Depth______ Time______
Gage Finish: Depth______ Time______
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow
Date:
Crew:
Gage Start: Depth______ Time______
Gage Finish: Depth______ Time______
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

% emb, 50-60%

Cover Code
A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

Substrate Code

1: organic debris	8: Coarse gravel 2-3
2: mud, soft clay	9: small cobble 3-6
3: silt <.002	10: med cobble 6-9
4: fine sand .002-.1	11: large cobble 9-12
5: coarse sand .1-.25	12: small boulder 12-24
6: fine gravel .25-1	13: large boulder >24
7: med gravel 1-2	14: bedrock

Dominant Subdominant . Percent Dominant

% shade at noon 70%

Transect No. T32 Segment No. 5 Unit No. Run 11-2-98

Backsight to Benchmark: 3.45
Height of Instrument:______
FS to Stage Zero Flow:______
SZF:______
WS Slope: (FS1−FS2)/Distance
WS Slope:(_____ − _____)/_____
BS to Benchmark: 3.45

Distance from LB Head Pin	Foresight	Cover					Substrate	
		A	W	S	B	O		
0.0	3.60		X			X	2/1	60
2	5.62		X			X	2/1	70
4	6.46		X				2/7	50
6	6.61						8/7	↓
8	6.49						↓	
10	6.19						8/9	
12	5.79						↓	
14	5.41		X					
16	5.12	X	X				7/2	50
18	4.92	X	X				↓	↓
20	4.78	X	X					
22	4.98	X	X				7/2	60
24	4.07	X	X			X	↓	↓
26	2.72	X	X			X		
27.5	2.14							

Benchmark Location:

Low Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 3.45 HI:______
FS to LWSEL: 5.47 LWSEL:______
FS to RWSEL: 5.47 RWSEL:______
Average WSEL:______
BS to Benchmark: 3.45

Medium Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

Imbed.

Cover Code

A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

Substrate Code

1: organic debris	8: Coarse gravel 2-3
2: mud, soft clay	9: small cobble 3-6
3: silt <.002	10: med cobble 6-9
4: fine sand .002-.1	11: large cobble 9-12
5: coarse sand .1-.25	12: small boulder 12-24
6: fine gravel .25-1	13: large boulder >24
7: med gravel 1-2	14: bedrock

Dominant Subdominant . Percent Dominant

% shade at noon

50%

11-2-98
1045

Transect No. T2 Segment No. 1 Unit ~~No.~~ Pool

Channel	Date: 11/2/98	Date:	Date:
Main ✓	Crew: BC / SP	Crew:	Crew:
Dominant___	Gage Start: Depth_____ Time 2 00	Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____
Subominant___	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____
Spawning___	Meter Calibration: S ✓ F ✓	Meter Calibration: S__ F__	Meter Calibration: S__ F__
	Photo: 1	Photo:	Photo:

Distance from LB Head Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
4.5	WE	0		0									
6		2.1		0									
8		2.5		0.1									
10		2.8		.2									
12		3 0		.1									
14		3.1		.1									
16		3 0		.1									
18		2.8		.2									
20		2.6		.1									
22		2.2		0									
24		1.7		0									
26		1.1		0									
26.9	WE	0		0									

Notes:

Transect No. T82 Segment No. 2 Unit ~~No.~~ POOL TAIL

Channel	Date: 11/2/98	Date:	Date:
ain ✓	Crew: BC/JP	Crew:	Crew:
ominant___	Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____
ubominant___	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____
pawning___	Meter Calibration: S__ F__	Meter Calibration: S__ F__	Meter Calibration: S__ F__
	Photo: 2	Photo:	Photo:

Distance rom LB lead Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
7	WE	0		0									
8		.1		0									
10		.1		0									
12		.3		.3									
14		.5		.5									
16		.7		.5									
18		.7		.7									
20		.5		.8									
22		.4		.8									
24		.2		.5									
25.5	WE	0		0									

Notes:

[illegible]

Transect No. ~~13~~2 Segment No. 3 Unit ~~No.~~ RUN

11-2-98

Channel			
Main ✓	Date: 11/2/98 Crew: BC/SP	Date: Crew:	Date: Crew:
Dominant___	Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____
Subominant___	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____
Spawning___	Meter Calibration: S__ F__	Meter Calibration: S__ F__	Meter Calibration: S__ F__
	Photo: 3	Photo:	Photo:

Distance from LB Head Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
15.5	WE	0		0									
16		0.3		.1									
18		1.0		.9									
20		0.7		.8									
22		0.7		.8									
24		0.4		.5									
26		0.2		0									
27	WE	0		0									

Notes:

Transect No. ~~1~~2 Segment No. 4 Unit ~~No.~~ RIFFLE 11-2-98

Channel
ain ✓
ominant___
bominant___
awning___

Date: 11/2/98
Crew: BC/SP
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
Meter Calibration: S ✓ F ✓
Photo: 4

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
Meter Calibration: S__ F__
Photo:

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
Meter Calibration: S__ F__
Photo:

istance om LB ead Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
3.9	WE	0		0									
4		0.2		.2									
6		0.1		.6									
7	WE	0		0									
8													
	DRY												
20													
22	WE	0		0									
24		.1		.4									
26		.2		.6									
28		.2		1.1									
30		.2		1.2									
32		.2		2.0									
34		.2		1.5									
36		.2		1.1									
38		.2		1.2									
40		.2		1.0									
42		.2		1.4									
44		.1		1.5									
46		.1		.3									
48		.1		0									
50		.1		.1									
52		.1		.1									
54		0		0									
54.2		0		0									

otes:

[illegible]

Transect No. 132 Segment No. 5 Unit No. RUN 11-2-98

Channel			
Main ✓ Dominant___ Subominant___ Spawning___	Date: 11/2/98 Crew: SC / SP Gage Start: Depth_____ Time_____ Gage Finish: Depth_____ Time_____ Meter Calibration: S__ F__ Photo: 5, 6 LOOKING US	Date: Crew: Gage Start: Depth_____ Time_____ Gage Finish: Depth_____ Time_____ Meter Calibration: S__ F__ Photo:	Date: Crew: Gage Start: Depth_____ Time_____ Gage Finish: Depth_____ Time_____ Meter Calibration: S__ F__ Photo:

Distance from LB Head Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
1.5	WE	0		0									
1.6		.2		0									
2		.2		0									
4		1.0		.1									
6		1.2		1.3									
8		1.0		.9									
10		.7		.2									
12		.3		-.1									
14		0		0									
5		1.1		.9									
7		1.1		1.4									
9		.8		.4									

Notes:

Transect No. 61 Segment No. 1 Unit No. F001

11-3-98

0830

12.5°C

9.4 mg/L

420 umhos

Backsight to Benchmark: 2.04
Height of Instrument: ______
FS to Stage Zero Flow: ______
SZF: ______
WS Slope: (FS1-FS2)/Distance
WS Slope: (_____ - _____)/_____
BS to Benchmark: 2.04

Benchmark Location:

Distance from LB Head Pin	Foresight	Cover					Substrate	
		A	W	S	B	O		
0.0	4.10					X	5/1	80
2	5.19	X	X			X	2/1	↓
4	7.22	X	X			X	↓	↓
6	7.43		X				4/2	80
8	7.45						↓	60
10	7.58						↓	↓
12	7.79						2/4	80
14	7.99						2/1	90
16	8.12						↓	80
18	8.25						2/7	70
20	8.31						↓	↓
22	8.39						↓	↓
24	8.38		X				2/1	80
26	8.20						↓	↓
28	7.78					X	↓	90
30	6.51		X			X	↓	↓
32	4.15		X		X	X	↓	80
34	5.22					X	↓	↓
3	6.85							
29	7.20							
31	5.39							

Low Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 2.04 HI: ______
FS to LWSEL: 6.09 LWSEL: ______
FS to RWSEL: 6.09 RWSEL: ______
Average WSEL: ______
BS to Benchmark: 2.04

Medium Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: ______ HI: ______
FS to LWSEL: ______ LWSEL: ______
FS to RWSEL: ______ RWSEL: ______
Average WSEL: ______
BS to Benchmark: ______

High Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: ______ HI: ______
FS to LWSEL: ______ LWSEL: ______
FS to RWSEL: ______ RWSEL: ______
Average WSEL: ______
BS to Benchmark: ______

% emb: 80%

% shade at noon 50%

Cover Code
A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

Substrate Code

1: organic debris	8: Coarse gravel 2-3
2: mud, soft clay	9: small cobble 3-6
3: silt <.002	10: med cobble 6-9
4: fine sand .002-.1	11: large cobble 9-12
5: coarse sand .1-.25	12: small boulder 12-24
6: fine gravel .25-1	13: large boulder >24
7: med gravel 1-2	14: bedrock

Dominant Subdominant . Percent Dominant

-oyote Creek @ [illegible]

Transect No. C1 Segment No. 2 Unit No. Pool Tail

11-3-98

Backsight to Benchmark: 2.04
Height of Instrument:______
FS to Stage Zero Flow:______
SZF:______
WS Slope: (FS1-FS2)/Distance
WS Slope:(_____ - _____)/_____
BS to Benchmark: 204

Benchmark Location:

Distance from LB Head Pin	Foresight	Cover					Substrate	
		A	W	S	B	O		
0.0	2.78					X	2/1	60
2	3.55					X	↓	↓
4	4.04		X				↓	↓
6	4.22		X				↓	↓
8	4.39		X				6/1	↓
10	4.38		X				↓	↓
12	4.68					X	↓	↓
14	4.78					X	2/1	↓
16	4.90		X				↓	↓
18	5.11		X			X	9/1	30
20	5.22		X			X	↓	60
22	5.13		X			X	↓	
24	5.20		X			X	↓	
26	5.64		X			X	↓	
28	6.04		X				9/2	50
30	6.48		X		X		2/9	60
32	6.76						9/5	↓
34	7.05						↓	↓
36	7.21						↓	↓
38	6.84						2/1	80
40	6.00		X			X	↓	↓
42	5.26					X	↓	↓
44	4.18					X	↓	70
46	3.60					X	↓	↓
46.5	3.52							

Low Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 2.04 HI:______
FS to LWSEL: 6.15 LWSEL:______
FS to RWSEL: 6.16 RWSEL:______
Average WSEL:______
BS to Benchmark: 204

Medium Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

% emb:
60%

% shade at noon:
50%

Cover Code
A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

Substrate Code

1: organic debris	8: Coarse gravel 2-3
2: mud, soft clay	9: small cobble 3-6
3: silt <.002	10: med cobble 6-9
4: fine sand .002-.1	11: large cobble 9-12
5: coarse sand .1-.25	12: small boulder 12-24
6: fine gravel .25-1	13: large boulder >24
7: med gravel 1-2	14: bedrock

Dominant Subdominant . Percent Dominant

Coyote Creek

Transect No. C1 Segment No. 3 Unit No. Run

11-3-98

Backsight to Benchmark: 2.04
Height of Instrument:______
FS to Stage Zero Flow:______
SZF:______
WS Slope: (FS1-FS2)/Distance
WS Slope:(_____ - _____)/_____
BS to Benchmark: 2.04

Distance from LB Head Pin	Foresight	Cover A	Cover W	Cover S	Cover B	Cover O	Substrate	
0.0	3.40		X			X	2/1	60
2	3.94		X			X	↓	↓
4	4.25		X			X	8/1	40
6	4.75		X			X		
8	5.01		X					
10	5.35		X					
12	5.28	X					↓	↓
14	5.25	X					2/1	50
16	5.72				X	X	↓	↓
18	7.34						6/5	60
20	7.56							
22	7.58						7/6	
24	7.95				X		2/1	
26	5.82				X	X		
28	5.45		X			X		
30	4.69		X			X		
32	3.90		X			X		↓
32.5	3.77							
17	6.67							
25	6.24							

Benchmark Location:

Low Flow

Date: 11/3/98
Crew: BK ST
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 2.04 HI:______
FS to LWSEL: 6.17 LWSEL:______
FS to RWSEL: 6.19 RWSEL:______
Average WSEL:______
BS to Benchmark: 2.04

Medium Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

% emb
70%

Cover Code

A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

Substrate Code

1: organic debris	8: Coarse gravel 2-3
2: mud, soft clay	9: small cobble 3-6
3: silt <.002	10: med cobble 6-9
4: fine sand .002-.1	11: large cobble 9-12
5: coarse sand .1-.25	12: small boulder 12-24
6: fine gravel .25-1	13: large boulder >24
7: med gravel 1-2	14: bedrock

Dominant Subdominant . Percent Dominant

% shade at noon
70%

oyote Creek @ Ballou Dr

Transect No. C1 Segment No. 4 Unit No. Run Tail/Riffle Head

11-3-98

Backsight to Benchmark: 2.04
Height of Instrument:______
FS to Stage Zero Flow:______
SZF:______
WS Slope: (FS1-FS2)/Distance
WS Slope:(_____ - _____)/_____
BS to Benchmark: 2.04

Benchmark Location:

Distance from LB Head Pin	Foresight	Cover					Substrate	
		A	W	S	B	O		
0.0	3.99					X	2/1	50
2	4.81					X	↓	
4	5.06						↓	
6	5.61						2/8	
8	5.62		X				↓	
10	5.26		X			X	2/1	
12	5.52		X			X		
14	5.86		X			X		60
16	6.10						↓	
18	7.21				X		2/8	
20	7.61		X				8/5	50
22	7.25		X		X		2/8	70
24	6.29		X		X		↓	80
26	5.63		X				2/1	
28	4.93		X			X		
30	4.51					X		
32	4.04					X		
33	3.84							
7	5.88							
9	5.39							
17	6.64							
21	7.62							

Low Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 2.04 HI:______
FS to LWSEL: 6.20 LWSEL:______
FS to RWSEL: 6.19 RWSEL:______
Average WSEL:______
BS to Benchmark: 2.04

Medium Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

% emb
60%

Cover Code
A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

Substrate Code

1: organic debris	8: Coarse gravel 2–3
2: mud, soft clay	9: small cobble 3–6
3: silt <.002	10: med cobble 6–9
4: fine sand .002–.1	11: large cobble 9–12
5: coarse sand .1–.25	12: small boulder 12–24
6: fine gravel .25–1	13: large boulder >24
7: med gravel 1–2	14: bedrock

Dominant Subdominant . Percent Dominant

% shade
at noon
80%

Coyote Creek @ Hallour Dr.

11-3-98

Transect No. C1 Segment No. 1 Unit No. Pool

Channel	Date: 11/3/98	Date:	Date:
Main ✓	Crew: Ox SP	Crew:	Crew:
Dominant___	Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____
Subominant___	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____
Spawning___	Meter Calibration: S__ F__	Meter Calibration: S__ F__	Meter Calibration: S__ F__
	Photo: 11	Photo:	Photo:

Distance from LB Head Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
2.2	WE	0		0									
3		.6		0									
4		1.1		0									
6		1.3		.05									
8		1.4		.15									
10		1.5		.2									
12		1.7		.2									
14		1.8		.2									
16		2.0		.2									
18		2.1		.2									
20		2.2		.25									
22		23		.2									
24		2.3		.2									
26		2.0		.1									
28		1.7		.1									
30		.7		.05									
31	WE	0		0									

Notes:

oyote Creek @ Balfour Dr. C1

11-3-98

Transect No. C1 Segment No. 2 Unit ~~No.~~ POOL TAIL

Channel	Date: 11/3/98	Date:	Date:
Iain ✓	Crew: BC SP	Crew:	Crew:
ominant___	Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____
ubominant___	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____
pawning___	Meter Calibration: S__ F__	Meter Calibration: S__ F__	Meter Calibration: S__ F__
	Photo: 12	Photo:	Photo:

Distance from LB Head Pin	Notes	Low Flow Depth	Low Flow Velocity 0.2	Low Flow Velocity 0.6	Low Flow Velocity 0.8	Medium Flow Depth	Medium Flow Velocity 0.2	Medium Flow Velocity 0.6	Medium Flow Velocity 0.8	High Flow Depth	High Flow Velocity 0.2	High Flow Velocity 0.6	High Flow Velocity 0.8
0.0													
29	WE	0		0									
30		.3		1.8									
31		.4		1.7									
32		.5		1.9									
33		.6		2.3									
34		.8		3.5									
35		.9		2.3									
36		1.0		1.3									
37		.9		0									
38		.6		0									
39		.1		0									
39.2	WE	E		0									

otes:

Coyote Creek @ Balfour Dr. C1

11-3-98

Transect No. C1 Segment No. 3 Unit ~~No.~~ RUN

Channel	Date: 11/3/98	Date:	Date:
Main ✓	Crew: SC SP	Crew:	Crew:
Dominant___	Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____
Subominant___	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____
Spawning___	Meter Calibration: S__ F__	Meter Calibration: S__ F__	Meter Calibration: S__ F__
	Photo: 13	Photo:	Photo:

Distance from LB Head Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
16.6	WE	0		0									
17		.2		-.05									
18		1.0		-.05									
19		1.1		.03									
20		1.2		.7									
21		1.5		1.0									
22		1.6		1.6									
23		1.7		1.8									
24		1.5		0									
25		.2		0									
25.5	WE												
21.5		1.6		1.1									
22.5		1.8		1.8									

Notes:

Coyote Creek @ Daltour Dr.

11-3-98

Transect No. C1 Segment No. 4 Unit No. RUN TAIL/HEAD RIFFLE

Channel			
ain ✓ ominant___ ubominant___ pawning___	Date: 11/3/98 Crew: Fsc SP Gage Start: Depth_____ Time_____ Gage Finish: Depth_____ Time_____ Meter Calibration: S__ F__ Photo: 14, 15 L US	Date: Crew: Gage Start: Depth_____ Time_____ Gage Finish: Depth_____ Time_____ Meter Calibration: S__ F__ Photo:	Date: Crew: Gage Start: Depth_____ Time_____ Gage Finish: Depth_____ Time_____ Meter Calibration: S__ F__ Photo:

Distance from LB Head Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
16.5	WE	0		0									
17		0.2		0.1									
17.5		0.5		0.5									
18		0.9		1.2									
18.5		1.0		1.3									
19		1.1		1.3									
19.5		1.2		1.6									
20		1.2		1.7									
20.5		1.3		1.5									
21		1.3		1.3									
21.5		1.2		1.4									
22		0.8		1.0									
22.5		0.4		0.8									
23		0.4		0.7									
24		0.1		0									
24.2	WE	0		0									

Notes:

Coyote Creek @ Dakota Dr

Transect No. C2 Segment No. 1 Unit No. Pool

C2

11-3-98

@ 1300

13.5°C

10.4 mg/L

420 umhos

Backsight to Benchmark: 333
Height of Instrument:______
FS to Stage Zero Flow:______
SZF:______
WS Slope: (FS1-FS2)/Distance
WS Slope:(_____ - _____)/_____
BS to Benchmark: 3.33

Benchmark Location:

Distance from LB Head Pin	Foresight	Cover A	Cover W	Cover S	Cover B	Cover O	Substrate	
0.0	2.05		X			X	2/1	60
2	2.65	X						↓
4	3.52	X						80
6	3.85	X						↓
8	4.03	X				X		60
10	4.32	X	X			X	↓	↓
12	5.42				X	X	8/5	50
14	5.68							
16	5.97							
18	6.01							
20	6.07							
22	5.96						↓	
24	5.70					X	8/4	↓
26	4.95				X	X	1/3	60
28	3.91	X				X	2/1	↓
30	3.50	X	X			X		80
32	2.79	X				X		↓
34	2.55	X				X	↓	60
11	5.29							
25	5.68							
27	4.27							

Low Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 3.33 HI:______
FS to LWSEL: 4.51 LWSEL:______
FS to RWSEL: 4.52 RWSEL:______
Average WSEL:______
BS to Benchmark: 333

Medium Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

% emb.

40%

Cover Code
A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

Substrate Code

1: organic debris	8: Coarse gravel 2-3
2: mud, soft clay	9: small cobble 3-6
3: silt <.002	10: med cobble 6-9
4: fine sand .002-.1	11: large cobble 9-12
5: coarse sand .1-.25	12: small boulder 12-24
6: fine gravel .25-1	13: large boulder >24
7: med gravel 1-2	14: bedrock

Dominant Subdominant . Percent Dominant

% shade at noon!

60%

oyote Creek @ Wakota Dr

cc

11-3-98

Transect No. C2 Segment No. 2 Unit No. Low Gradient Riffle

Backsight to Benchmark: 3.33
Height of Instrument:______
FS to Stage Zero Flow:______
SZF:______
WS Slope: (FS1-FS2)/Distance
WS Slope:(_____ - _____)/_____
BS to Benchmark: 3.33

Distance from LB Head Pin	Foresight	Cover A	Cover W	Cover S	Cover B	Cover O	Substrate	
0.0	3.20		X			X	1/3	50
2	3.82		X			X	2/1	60
4	4.41		X			X	↓	↓
6	4.69					X	↓	↓
8	4.65					X	↓	↓
10	4.71					X	↓	↓
12	5.10					X	8/9	50
14	5.04					X	↓	↓
16	4.89					X	↓	↓
18	4.88					/	↓	↓
20	4.96						↓	↓
22	4.98						↓	↓
24	5.16	X				X	8/5	40
26	4.53	X					2/1	60
28	3.90	X						↓
30	3.86	X	X			X		↓
32	–	X	X					↓
34	3.70	X						↓
36	3.33	X	X					↓
38	2.97	X	X			X		↓
40	2.94	X	X			X		↓
11	5.0							
25	4.85							

Benchmark Location:

Low Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 3.33 HI:______
FS to LWSEL: 4.66 LWSEL:______
FS to RWSEL: 4.71 RWSEL:______
Average WSEL:______
BS to Benchmark: 3.35

Medium Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

% emb: 40%

Cover Code
A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

Substrate Code

1: organic debris	8: Coarse gravel 2-3
2: mud, soft clay	9: small cobble 3-6
3: silt <.002	10: med cobble 6-9
4: fine sand .002-.1	11: large cobble 9-12
5: coarse sand .1-.25	12: small boulder 12-24
6: fine gravel .25-1	13: large boulder >24
7: med gravel 1-2	14: bedrock

Dominant Subdominant . Percent Dominant

% Shade at noon: 100%

oyote Creek @ Dakota Dr,

Transect No. C2 Segment No. 3 Unit No. High Gradient Riffle

C2

11-3-98

Backsight to Benchmark: 3.33
Height of Instrument:______
FS to Stage Zero Flow:______
SZF:______
WS Slope: (FS1-FS2)/Distance
WS Slope:(_____ - _____)/_____
BS to Benchmark: 3.33

Benchmark Location:

Distance from LB Head Pin	Foresight	Cover					Substrate	
		A	W	S	B	O		
0.0	3.29		X			X	7/1	40
2	3.19		X				8/1	↓
4	3.39		X			X	↓	↓
6	3.53						↓	↓
8	3.68	X					↓	↓
10	3.91	X					2/1	60
12	4.57	X					↓	80
14	5.37					X	8/4	40
16	5.42						8/5	50
18	5.46						↓	40
20	5.80						↓	↓
22	5.90						↓	↓
24	5.90						↓	↓
26	6.01						7/5	50
28	6.05		X				5/7	40
30	6.11		X		X		↓	↓
32	4.92				X		↓	↓
34	4.75		X				6/12	↓
36	4.36		X				6/4	50
38	3.58						4/1	60
40	3.08						4/1	80
42	2.53						↓	60
11	4.10							
13	5.17							
31	5.81							

Low Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 3.33 HI:______
FS to LWSEL: 5.67 LWSEL:______
FS to RWSEL: 5.62 RWSEL:______
Average WSEL:______
BS to Benchmark:______

Medium Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow

Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

% emb: 40%

Cover Code

A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

Substrate Code

1: organic debris	8: Coarse gravel 2-3
2: mud, soft clay	9: small cobble 3-6
3: silt <.002	10: med cobble 6-9
4: fine sand .002-.1	11: large cobble 9-12
5: coarse sand .1-.25	12: small boulder 12-24
6: fine gravel .25-1	13: large boulder >24
7: med gravel 1-2	14: bedrock

Dominant Subdominant . Percent Dominant

% shade at noon: 40%

Coyote Creek @ Dakota Pk. Transect No. C2 Segment No. 4 Unit No. Run

C 2
11-3-98

Backsight to Benchmark: 3.33
Height of Instrument:______
FS to Stage Zero Flow:______
SZF:______
WS Slope: (FS1–FS2)/Distance
WS Slope:(_____ – _____)/_____
BS to Benchmark: 3.33

Distance from LB Head Pin	Foresight	Cover A	Cover W	Cover S	Cover B	Cover O	Substrate	
0.0	4.09		X			X	4/1	40
2	4.25					X	↓	↓
4	4.79					X	↓	↓
6	6.84		X		X	X	5/6	30
8	7.02						↓	50
10	7.06						5/7	40
12	7.29						6/7	↓
14	6.71		X		X	X	6/2	30
16	5.34		X			X	7/4	↓
18	5.18		X			X	4/5	50
20	4.10		X			X	↓	40
22	2.54		X				2/1	80
5	6.30							
13	7.21							
15	5.35							
17	5.42							
19	4.73							

Benchmark Location:

Low Flow
Date: 3/11/98
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark: 3.33 HI:______
FS to LWSEL: 6.22 LWSEL:______
FS to RWSEL: 6.23 RWSEL:______
Average WSEL:______
BS to Benchmark:______

Medium Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

High Flow
Date:
Crew:
Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____
BS to Benchmark:______ HI:______
FS to LWSEL:______ LWSEL:______
FS to RWSEL:______ RWSEL:______
Average WSEL:______
BS to Benchmark:______

% emb = 30%

% shade at noon 50%

Cover Code
A:AqVeg W:Wood S:Subsrt B:Bank O:Ovhd

Substrate Code

1: organic debris	8: Coarse gravel 2–3
2: mud, soft clay	9: small cobble 3–6
3: silt <.002	10: med cobble 6–9
4: fine sand .002–.1	11: large cobble 9–12
5: coarse sand .1–.25	12: small boulder 12–24
6: fine gravel .25–1	13: large boulder >24
7: med gravel 1–2	14: bedrock

Dominant Subdominant . Percent Dominant

oyote Creek @ Dakota Dr.

C2
11-3-98

Transect No. C2 Segment No. 1 Unit ~~No.~~ Pool

Channel			
Main ✓ Dominant___ Subominant___ Spawning___	Date: 11/3/98 Crew: BC SD Gage Start: Depth_____ Time_____ Gage Finish: Depth_____ Time_____ Meter Calibration: S__ F__ Photo: 16	Date: Crew: Gage Start: Depth_____ Time_____ Gage Finish: Depth_____ Time_____ Meter Calibration: S__ F__ Photo:	Date: Crew: Gage Start: Depth_____ Time_____ Gage Finish: Depth_____ Time_____ Meter Calibration: S__ F__ Photo:

Distance from LB Head Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
10.5	WE	0		0									
11		.2		0									
12		.9		.2									
14		1.2		.4									
16		1.4		.3									
18		1.5		.4									
20		1.5		.4									
22		1.3		.3									
24		1.2		.3									
25		1.1		.25									
26		.2		.05									
26.5	WE	0		0									

Notes:

Coyote Creek (9) Dakota Dr. C2

11-3-98

Transect No. C2 Segment No. 2 Unit ~~No.~~ LGR

Channel	Date: 11/3/98	Date:	Date:
Main ✓	Crew: BC SP	Crew:	Crew:
Dominant___	Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____
Subominant___	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____
Spawning___	Meter Calibration: S__ F__	Meter Calibration: S__ F__	Meter Calibration: S__ F__
	Photo: 17	Photo:	Photo:

Distance from LB Head Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
10	WE	0		0									
11		.3		.4									
12		.4		1.6									
14		.4		1.3									
16		.2		.8									
18		.2		.9									
20		.2		1.4									
22		.3		2.0									
24		.3		1.2									
25		.2		.2									
25.5	WE	0		0									

Notes:

oyote Creek @ Dakota Dr.

11-3-98

Transect No. C2 Segment No. 3 Unit ~~No.~~ HC2

Channel
ain ✓
ominant___
ibominant___
awning___

Date: 11/3/98	Date:	Date:
Crew: BC SP	Crew:	Crew:
Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____	Gage Start: Depth_____ Time_____
Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____	Gage Finish: Depth_____ Time_____
Meter Calibration: S__ F__	Meter Calibration: S__ F__	Meter Calibration: S__ F__
Photo: 18	Photo:	Photo:

istance rom LB ead Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
19.2	WE	0		0									
20		.2		.3									
21		.2		.9									
22		.2		1.3									
23		.2		1.6									
24		.3		2.1									
25		.3		1.3									
26		.4		1.8									
27		.3		2.4									
28		.3		2.6									
29		.4		2.3									
30		.5		2.1									
31		.4		.1									
31.3	WE												

Notes:

Creek @ Dakota Dr.

Transect No. C2 Segment No. 4 Unit No. RUN

11-3-98

Channel	Date: 3/11/98 Crew: BC SP	Date: Crew:	Date: Crew:
ain ✓	Gage Start: Depth____ Time____	Gage Start: Depth____ Time____	Gage Start: Depth____ Time____
ominant___	Gage Finish: Depth____ Time____	Gage Finish: Depth____ Time____	Gage Finish: Depth____ Time____
ubominant___	Meter Calibration: S__ F__	Meter Calibration: S__ F__	Meter Calibration: S__ F__
pawning___	Photo 19, 20 LUS	Photo:	Photo:

istance rom LB Head Pin	Notes	Low Flow				Medium Flow				High Flow			
			Velocity				Velocity				Velocity		
		Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8	Depth	0.2	0.6	0.8
0.0													
5.5	WE	0		0									
6		.6		-.2									
6.5		.8		-.2									
7		.8		-.1									
7.5		.5		.1									
8		.8		.3									
8.5		.9		.9									
9		.9		1.7									
9.5		.9		1.8									
10		.9		1.5									
10.5		.9		1.7									
11		.9		2.2									
11.5		.9		2.3									
12		.9		.7									
12.5		1.0		-.05									
13		1.0		-.2									
13.5		1.0		-.2									
14		.4		-.2									
14.5	WE	0		0									

Notes:

DATE: December 15, 1998

TO: Don Arnold - City of San Jose
Tom Grieb - Tetra Tech
Chuck Hanson
Scott Cressey

BC

FROM: Beth Campbell and Tom Cannon

SUBJECT: Results of the Habitat Survey on Lower Coyote Creek

INTRODUCTION

From November 18 through November 21, 1998, Jeff Lafer (a Jones & Stokes Associates [JSA] hydrologist) and Beth Campbell surveyed Coyote Creek (Santa Clara County) from Capitol Expressway downstream to approximately 1 mile below Dixon Landing Road (Appendix A). The purpose of the survey was to classify the habitat available to fish for the City of San Jose's Streamflow Augmentation Pilot Study and identify potential monitoring sites as well as barriers to migration. Earlier (November 2-3), JSA established two treatment and two control monitoring sites within 1 mile of the proposed site of augmentation flow release. These sites will be used to apply the instream flow incremental methodology (IFIM) to determine the changes in stream depth and velocity patterns that occur with changes in flow. This most recent survey was more broad in that it involved general habitat mapping over 15 miles of Coyote Creek. Information from this survey will be used to select sites for monitoring fish habitat using the methods of the Fisheries and Aquatic Habitat Collaborative Effort (FAHCE) study team, and to monitor the presence of spawning adult and rearing or outmigrating juvenile steelhead and chinook salmon in Coyote Creek.

METHODS

During the survey, we walked and, when necessary, canoed the entire reach of lower Coyote Creek from Capitol Expressway downstream to State Route 237 (distance = 12.4 miles). Streamflow was generally 5-7 cubic feet per second (cfs). Fish habitat was classified by type as pool, run, or riffle using the methods of McCain et al. (1990). The length of each habitat type was measured using a hip chain. General habitat characteristics (e.g., undercut banks, instream woody material [IWM]) also were recorded. Habitat type and other geographical features were mapped and

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referenced by river mile (RM). RM 0 was considered to be at Dixon Landing Road (Cressey pers. comm.). Actual mileage was calculated by summing the lengths of the habitats. Surveyed mileage differed slightly from miles calculated using topographic maps (as per Cressey). The locations of major road crossings, large areas of spawning gravel, and potential barriers to the upstream migration of adult anadromous fish also were mapped using Global Positioning System (GPS) coordinates. A Geoexplorer 2 GPS unit (Trimble Navigation; accuracy = 300 feet), and Topo! software (Wildflower Productions; accuracy = 300 feet) were used to complete the mapping. Potential barriers, including shallow riffles, artificial structures, and debris jams, were identified based on professional judgement involving a qualitative evaluation of variables such as water depth and velocity, length of traverse, local cover, and upstream and downstream pool or thalweg structure (Abel pers. comm.). Most potential barriers were photographed.

Downstream of State Route 237, the habitat in Coyote Creek is tidally influenced. Stream hydraulics vary on an hourly basis; therefore, there was no attempt to classify the habitat as anything other than tidal sloughs. Portions of this reach were accessed using a combination of canoeing and driving or walking along levee roads to identify potential barriers or unusual habitat features. Various locations were photographed at low tide. The most downstream access point was near Lakeview Boulevard in the city of Fremont.

RESULTS AND DISCUSSION

A total of 324 pools, runs, and riffles were identified in Coyote Creek between State Route 237 and Capitol Expressway (Table 1, Figure 1). Pools were the most numerous habitat type and tended to be much longer than riffles or runs; therefore, 76% of this reach of Coyote Creek comprises pool habitat, whereas, only 14% comprises runs and 10% comprises riffles. Although some scour pools were present, most of the long habitat types were backwater pools formed by debris jams. The longest habitat type surveyed, located adjacent to Williams Street Park downstream of Interstate 280, was a backwater pool more than 1 mile long. The pattern of distribution of pools, runs, and riffles is fairly even throughout the reach, although both stream channel width and habitat type length are smaller farther upstream. Five long (>50 feet) riffle areas with gravel adequate for salmonid spawning were identified (Table 2, Figure 2). Three of these areas are within 2 miles downstream of the proposed site of project flow-augmentation release; the other two areas are located 6 or more miles downstream. Shaded riverine aquatic (SRA) cover, an important component of fish habitat, was abundant throughout Coyote Creek. Undercut banks, large IWM, and an extensive riparian canopy were common except near major roads and downstream of State Route 237, where the habitat was tidal slough (Figure 3).

No riffles or artificial structures were found that would entirely block the passage of anadromous salmonids under the flow conditions present during the survey. (In fact, a fresh chinook salmon carcass was found at RM 7.3.) However, 13 shallow riffles, artificial structures (i.e., a concrete weir and a low-flow vehicle crossing with culverts) or areas with debris (e.g., shopping carts, concrete rubble, etc.) that may be barriers to fish passage during low flow conditions were found (Table 2, Figure 4). It is likely that the low-flow vehicle crossing (RM 12.8) could most critically impede fish passage. Culverts at this site may impede fish passage under high flow conditions because water running through these culverts during high flow can be at extreme velocities (Figure 5). It is recommended that the conditions under which the identified shallow riffles and artificial structures prevent steelhead and chinook salmon passage be evaluated by collecting detailed data on water depth and velocity and channel slope or barrier height and applying the species-specific passage criteria of Stuart (1962), Thompson (1972), U.S. Forest Service (1977), Powers and Orsborn (1985), and Reiser and Peacock (1985). Jones & Stokes Associates recently completed such an evaluation for the Guadalupe River and Guadalupe Creek (Leone 1998).

An additional 10 debris jams upstream of Interstate 880 (RM 6.5) comprising wood, downed trees, and trash could be partial barriers. Most of the concrete rubble and shopping carts and some debris jams were located under or near bridges. Bridge supports may trap debris and concrete rubble may be present as a result of bridge construction. People living under the bridges may increase the amount of trash in the immediate area (Figure 6).

In conclusion, lower Coyote Creek downstream of Capitol Expressway has potential spawning and rearing habitat for chinook salmon and steelhead. This reach of Coyote Creek could provide good potential rearing habitat for juvenile chinook salmon if flow, water temperature, and water quality are adequate. Chinook salmon fry are known to rear in low-velocity freshwater habitats as well as tidal sloughs and estuaries. Adult chinook salmon migrate upstream in fall; adult steelhead migrate upstream in winter when flow is usually higher. Therefore, the potential barriers that were identified are more likely to affect the passage of adult chinook salmon than adult steelhead. Adult chinook salmon are also more vulnerable to poaching under these conditions.

We plan to address some of these issues in our proposed aquatic monitoring program. Identification of potential spawning areas near the proposed site of flow augmentation is included in our project monitoring protocol. We also plan to survey for rearing and migrating juvenile salmonids. Representative locations in Coyote Creek will be surveyed and a more detailed description of the habitat using the methods of the FAHCE study team will be developed. These locations will be monitored before and after the initiation of the Streamflow Augmentation Project scheduled for July 1999.

CITATIONS

Printed References

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Cressey, Scott. Independent fisheries biologist. December 4, 1998 - telephone conversation regarding survey data sheets.

Table 1. Description and Abundance of Habitat Types Surveyed in Coyote Creek,
Capitol Expressway to State Route 237
(November 18-21, 1998)

Habitat Type	Mean Length (feet)	Median Length (feet)	Range (feet)	Number	Total Length (miles)
Pool	384	181	12-5,499	130	9.4
Run	106	78	12-1,000	85	1.7
Riffle	63	46	7-317	109	1.3

Table 2. Location of Geographical Landmarks, Potential Barriers to Anadromous Fish Passage, and Large (>50 feet long) Areas of Spawning Gravel in Coyote Creek from Dixon Landing to Capitol Expressway

River Mile	Description of Landmark, Barrier, or Spawning Habitat[a]	Latitude and Longitude
0	**Dixon Landing Road**	37°27'17" 121°55'35'
2.9	**State Route 237** (Limit of tidal influence)	37°25'22" 121°55'36"
5.4	**Montague Expressway**	37°23'46" 121°54'55"
5.9	Long (0.3 mile) riffle-run sequence with good spawning gravel	37°23'24" 121°54'35"
6.5	**Interstate 880**	37°22'57" 121°54'16"
6.8	Potential Barrier: Shallow Riffle	37°22'47" 121°53'59"
6.9	Potential Barrier: Fish weir	37°22'44" 121°53'55"
7.9	Potential Barrier: Shallow riffle	37°22'11" 121°53'10"
8.2	Spawning Gravel (113 feet)	37°22'05" 121°52'50"
8.2	**Upper Penetencia Creek**	37°22'05" 121°52'47"
8.9	**U.S. 101**	37°21'36" 121°52'25"
9.1	**Miguelita Creek**	37°21'24" 121°52'25"
11.2	Potential Barrier: Shallow Riffle	37°19'49" 121°52'05"
11.2	**Interstate 280**	37°19'48" 121°52'05"

River Mile	Description of Landmark, Barrier, or Spawning Habitat[a]	Latitude and Longitude
11.5	Potential Barrier: Shallow Riffle	37°19'40" 121°52'02"
11.7	Potential Barrier: Concrete Rubble	37°19'37" 121°51'58"
12.5	Spawning Gravel (82 ft)	37°19'10" 121°51'08"
12.7	Potential Barrier: Concrete Rubble	37°19'00" 121°51'15"
12.8	Potential Barrier: Low Flow Vehicle Crossing	37°18'58" 121°51'14"
13.4	Spawning Gravel (158 ft)	37°18'52" 121°50'49"
13.5	Potential Barrier: Concrete Rubble	37°18'47" 121°50'48"
13.7	Potential Barrier: Concrete Rubble	37°18'42" 121°50'38"
13.8	Potential Barrier: Shallow Riffle	37°18'38" 121°50'39"
13.8	**Tully Road**	37°18'37" 121°50'38"
14.2	Spawning Gravel (155 ft)	37°18'29" 121°50'20"
14.7	Potential Barrier: Steel Beam	37°18'06" 121°50'06"
14.9	Potential Barrier: Broken Concrete Pipe	37°18'01" 121°49'55"
15.3	**Capitol Expressway**	37°17'54" 121°49'29"

Note:

[a] Entries in boldface type represent major points of reference.

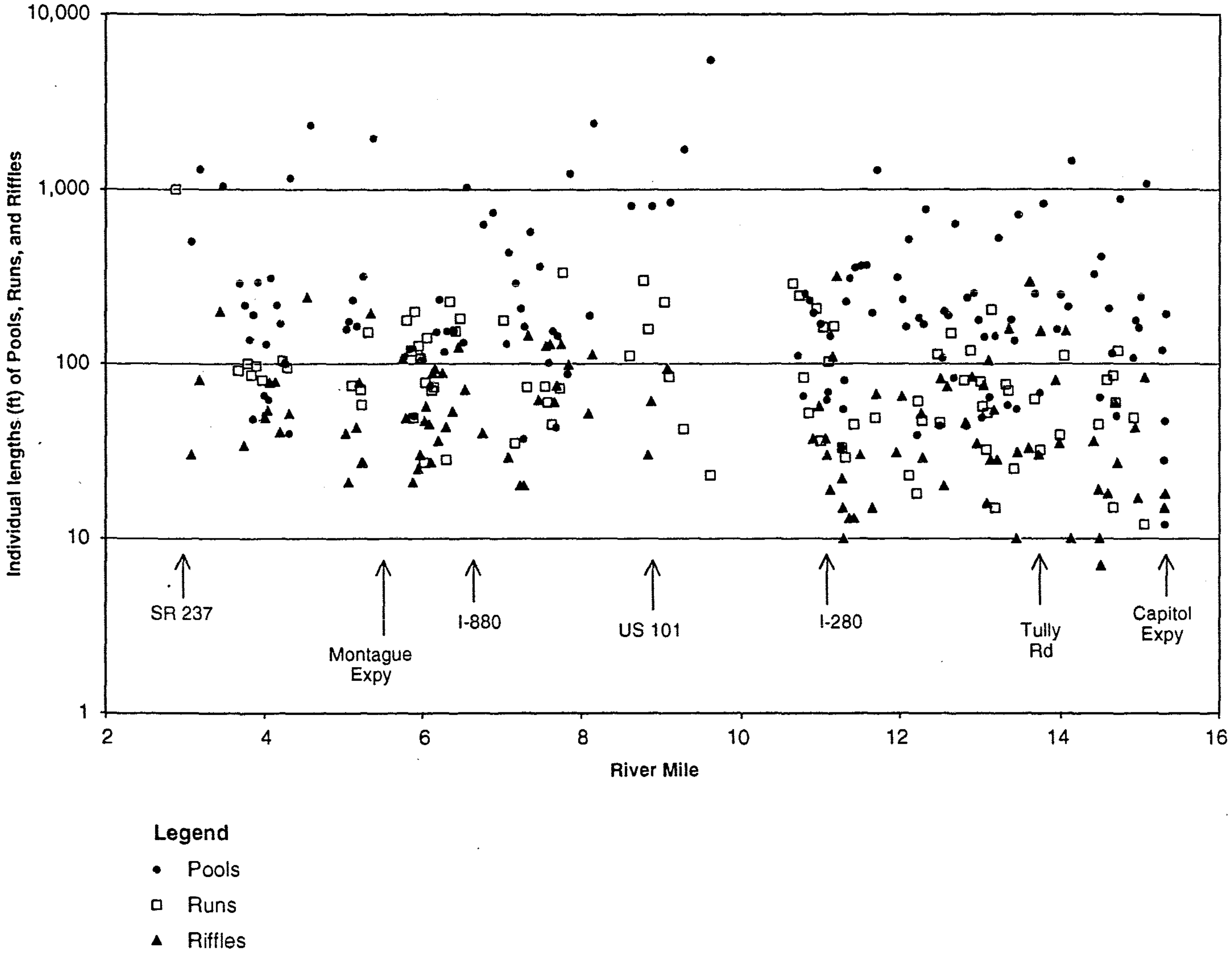
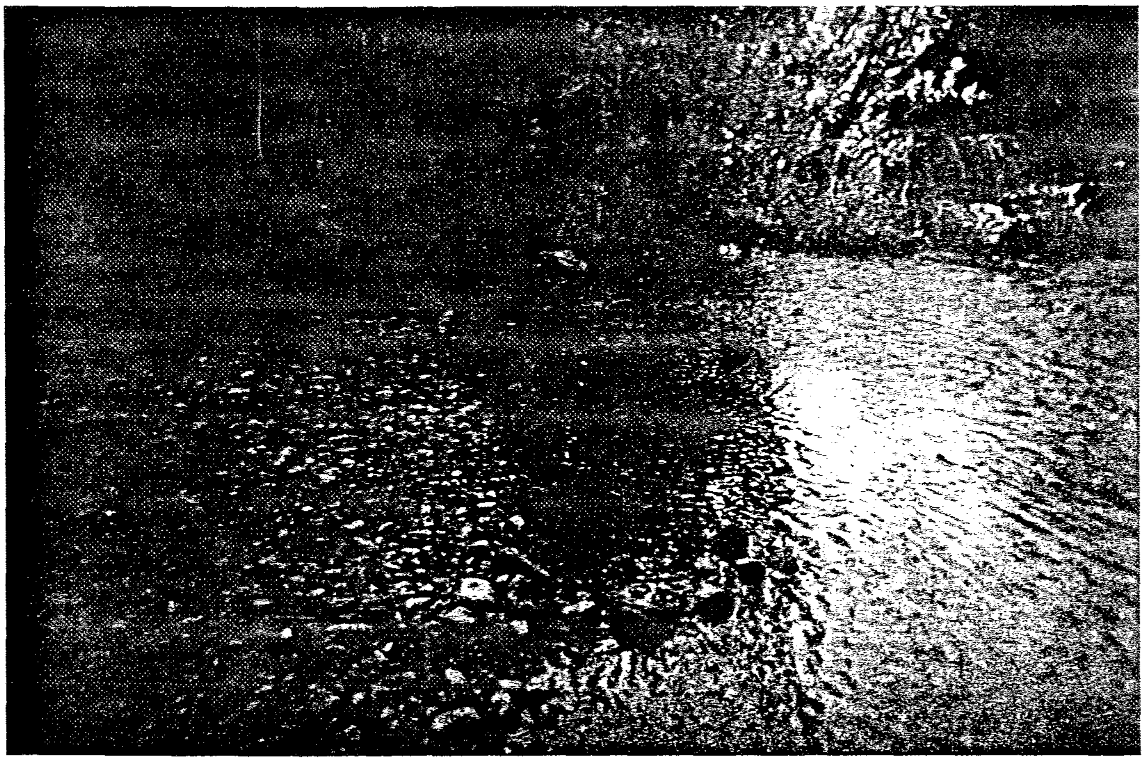
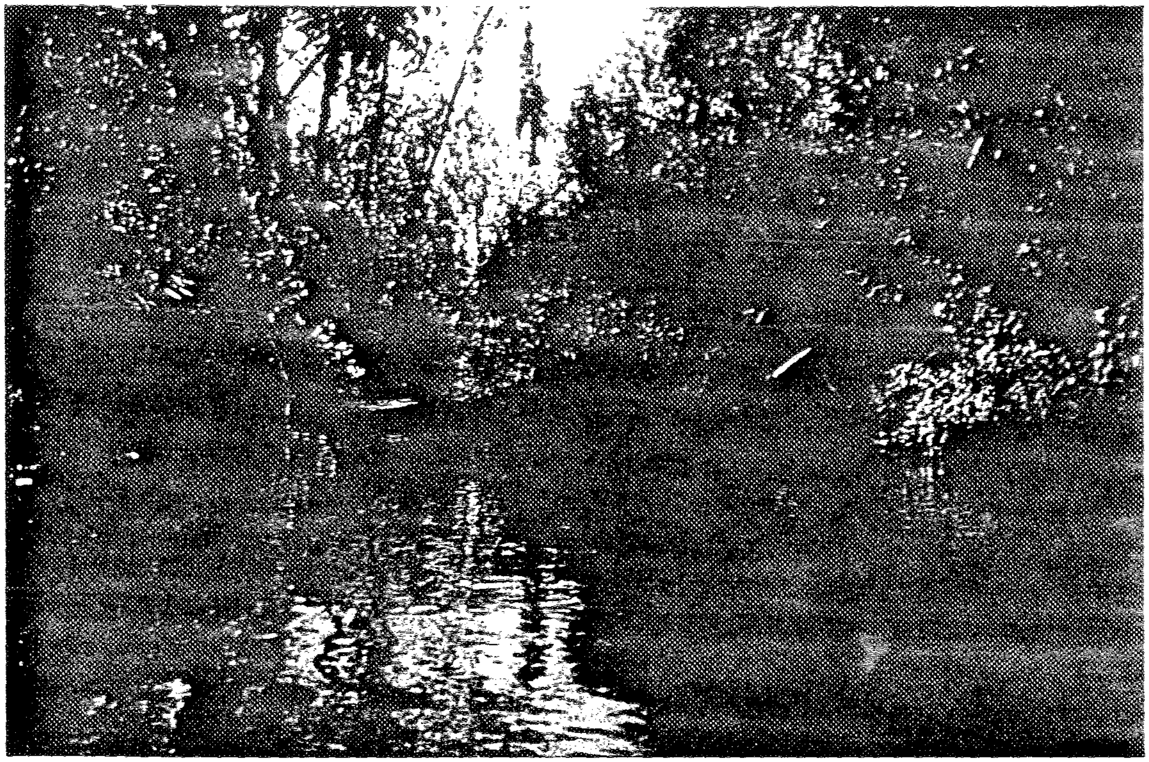


Figure 1
Lengths of Pools, Runs, and Riffles in Coyote Creek between State Route 237 and Capitol Expressway, November 18-21, 1998

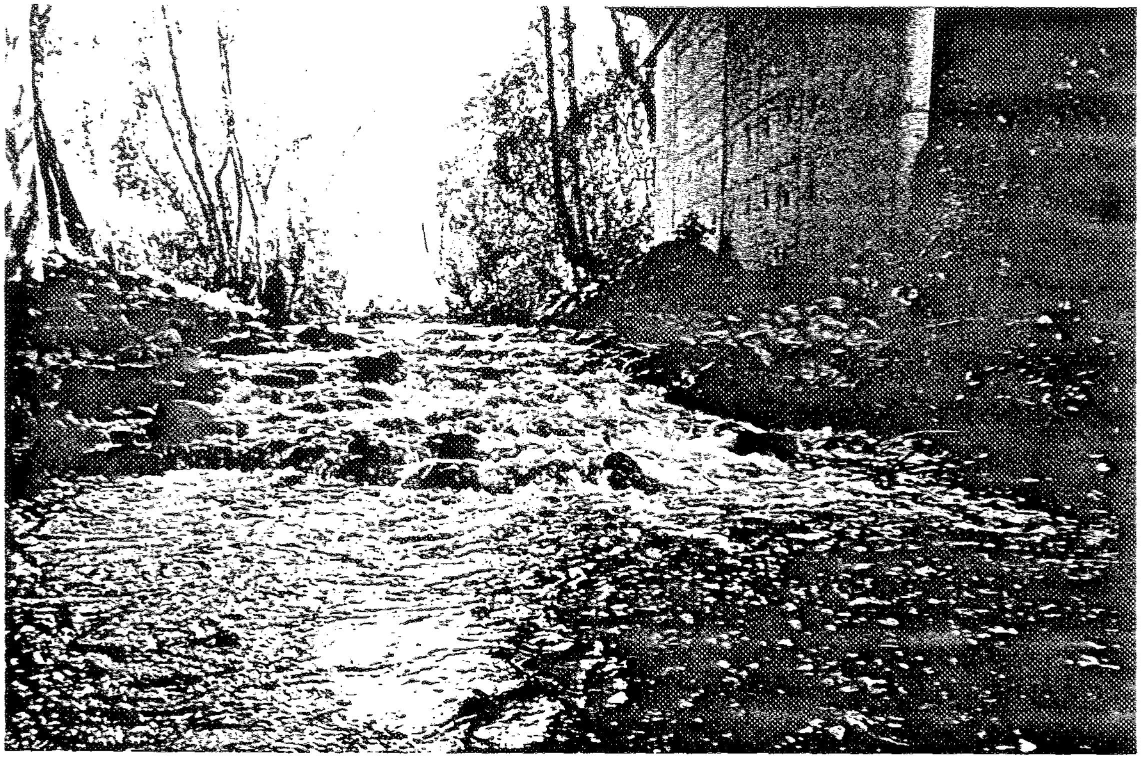


Spawning Gravel (RM 8.2)

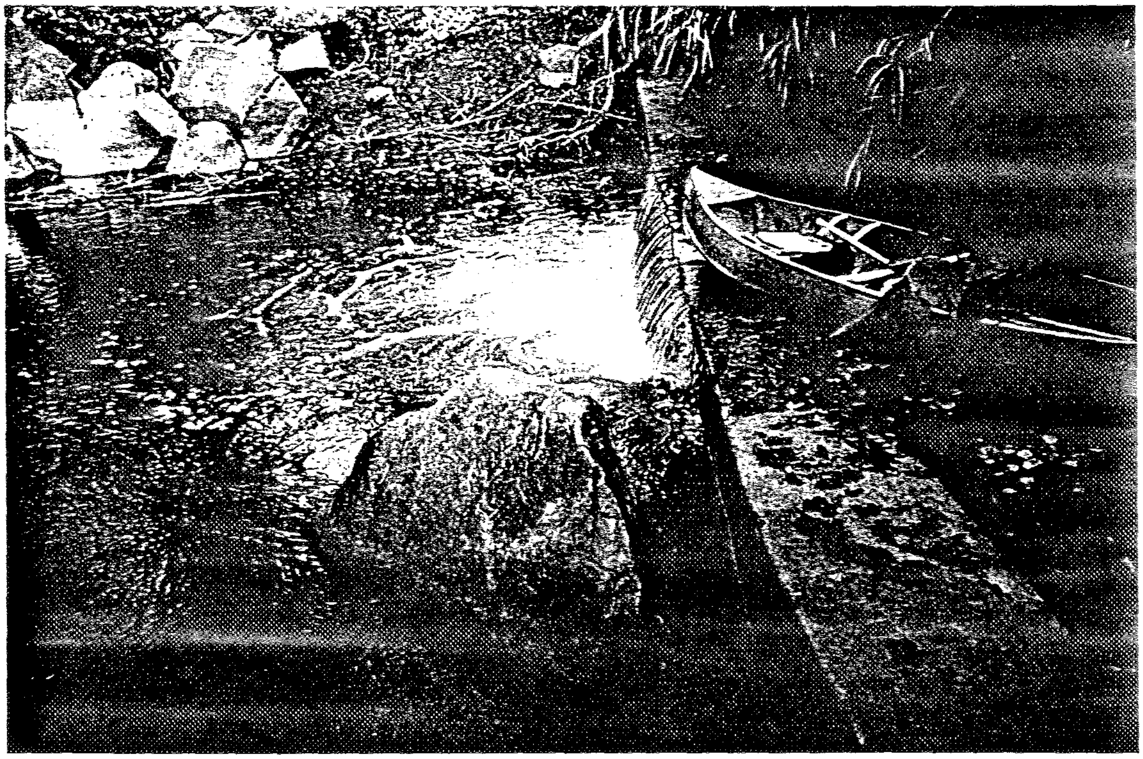


Typical Shaded Riverine Aquatic Habitat in Coyote Creek (RM 12.3)

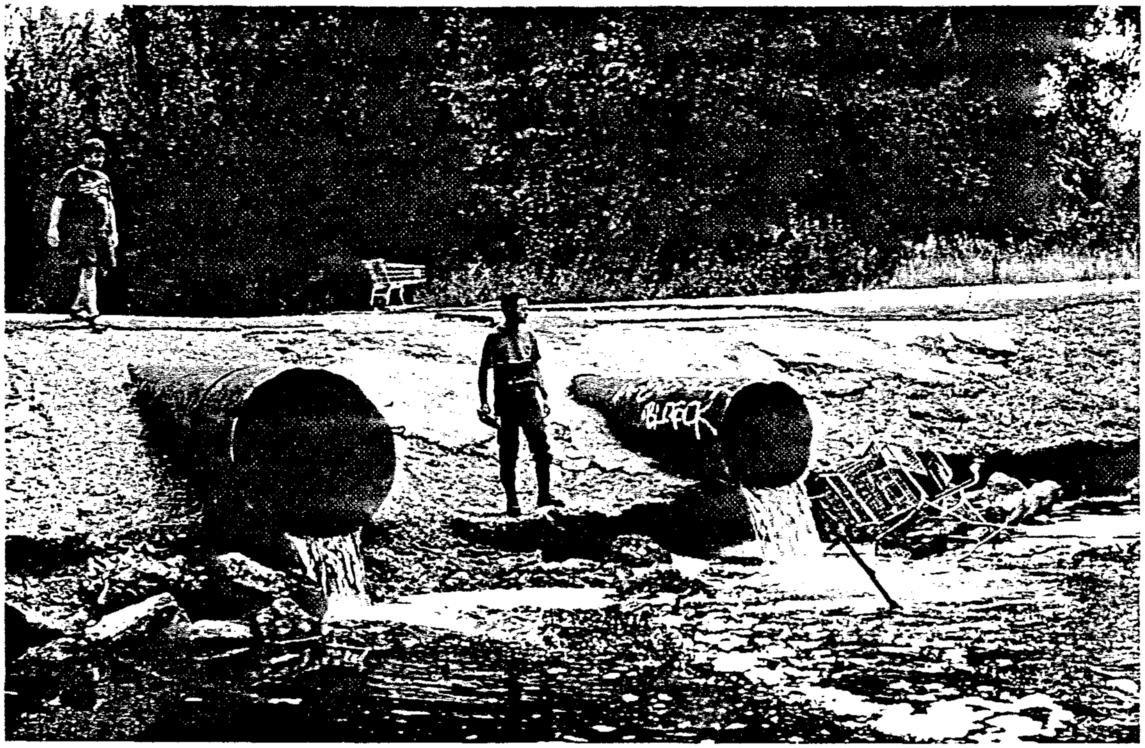
Typical Tidal Slough Habitat in Coyote Creek (RM 0.7)



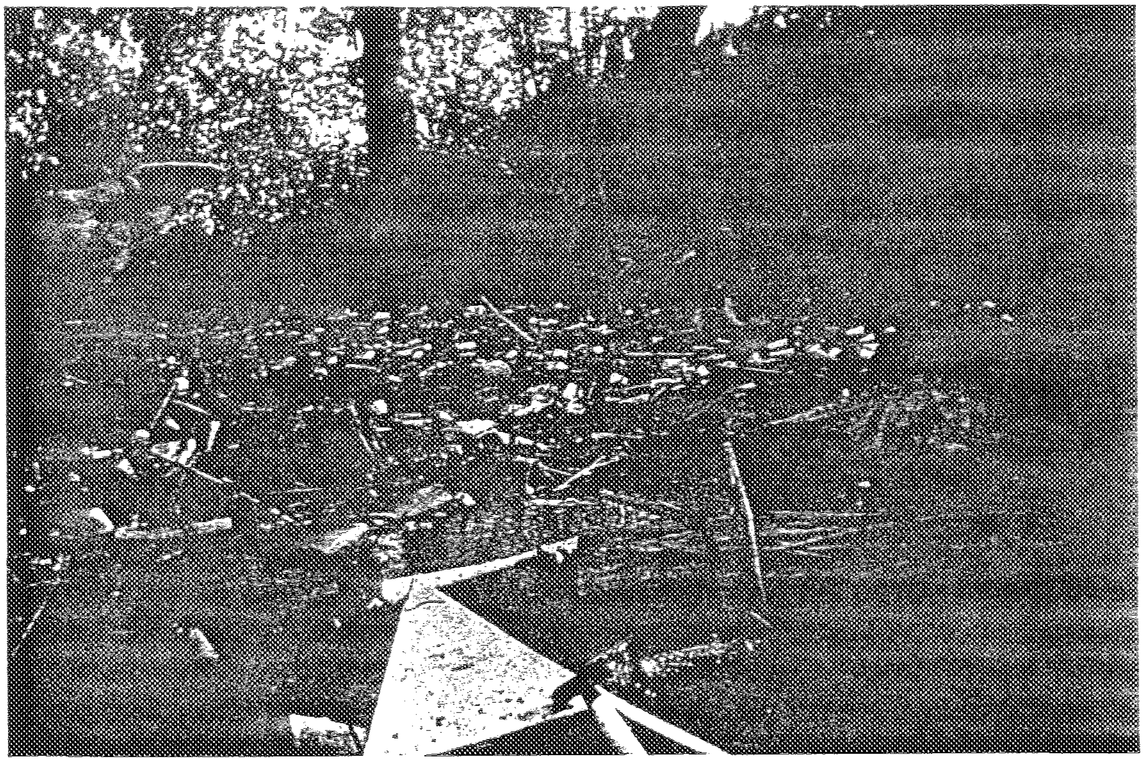
Potential Barrier (Shallow Riffle) under Ridder Park Drive Bridge (RM 6.8)



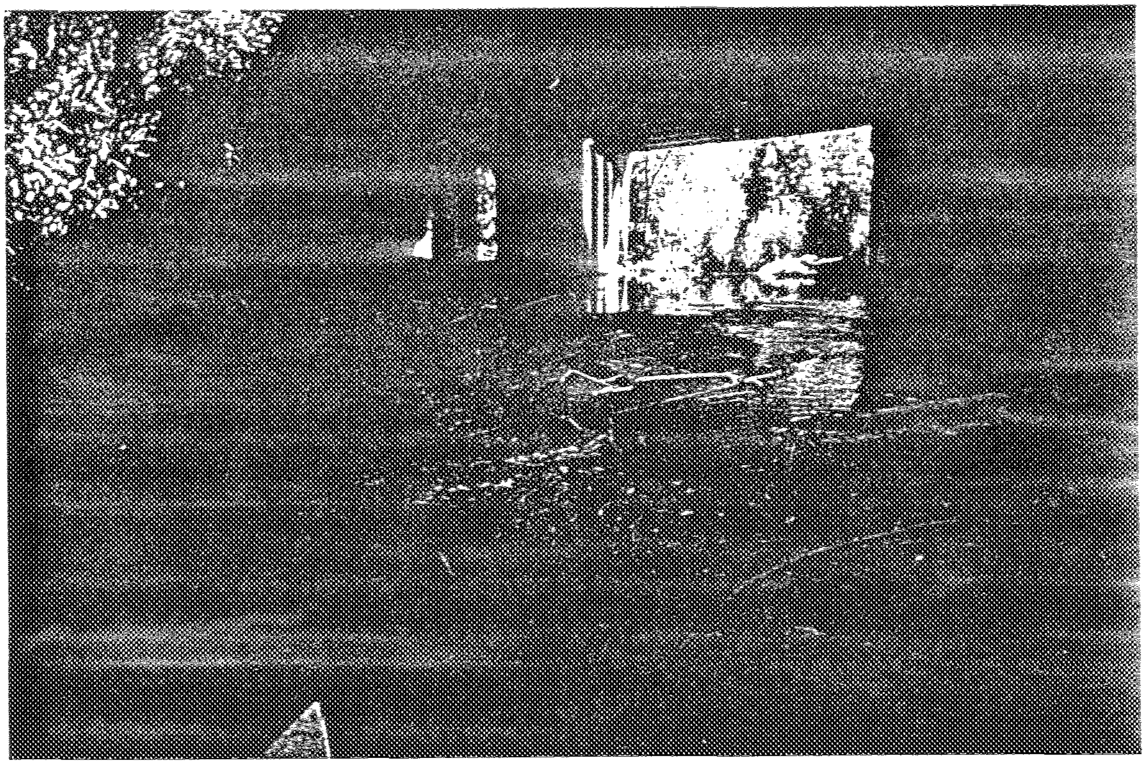
Potential Barrier (Concrete Weir) under Union Pacific Railroad Trestle (RM 6.9)



Potential Barrier (Low-Flow Vehicle Crossing) Located 0.2 Mile Upstream of Capitol Expressway (i.e., Out of the Survey Area) but Similar to the One at RM 12.8



Woody Debris Jam and Trash in Pool near William Street Park (RM 10.5)



Shallow Riffle Partially Blocked by Woody Debris and Shopping Carts
at Story Road Bridge (RM 11.2)

APPENDIX A. MAPS OF SURVEY SITES

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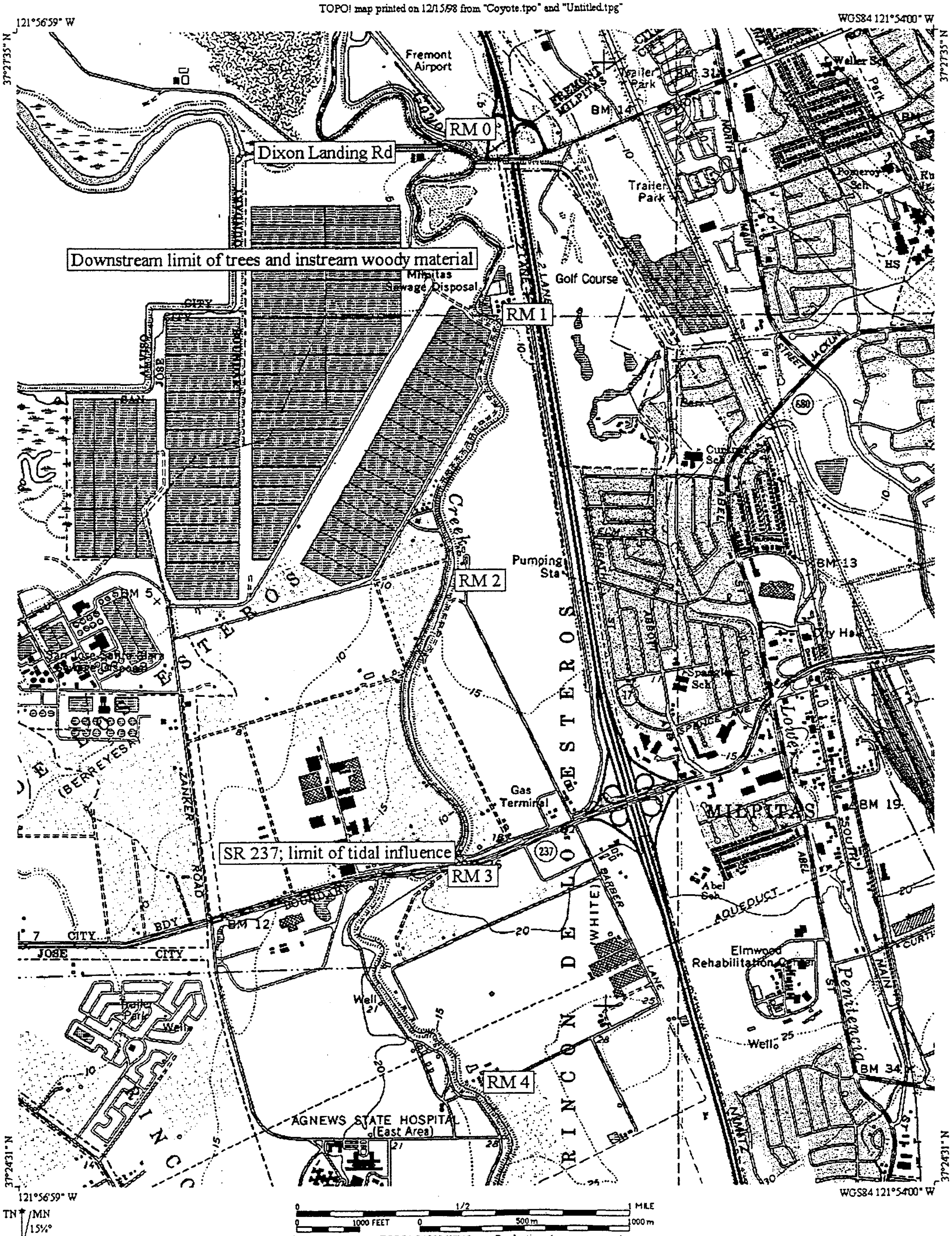

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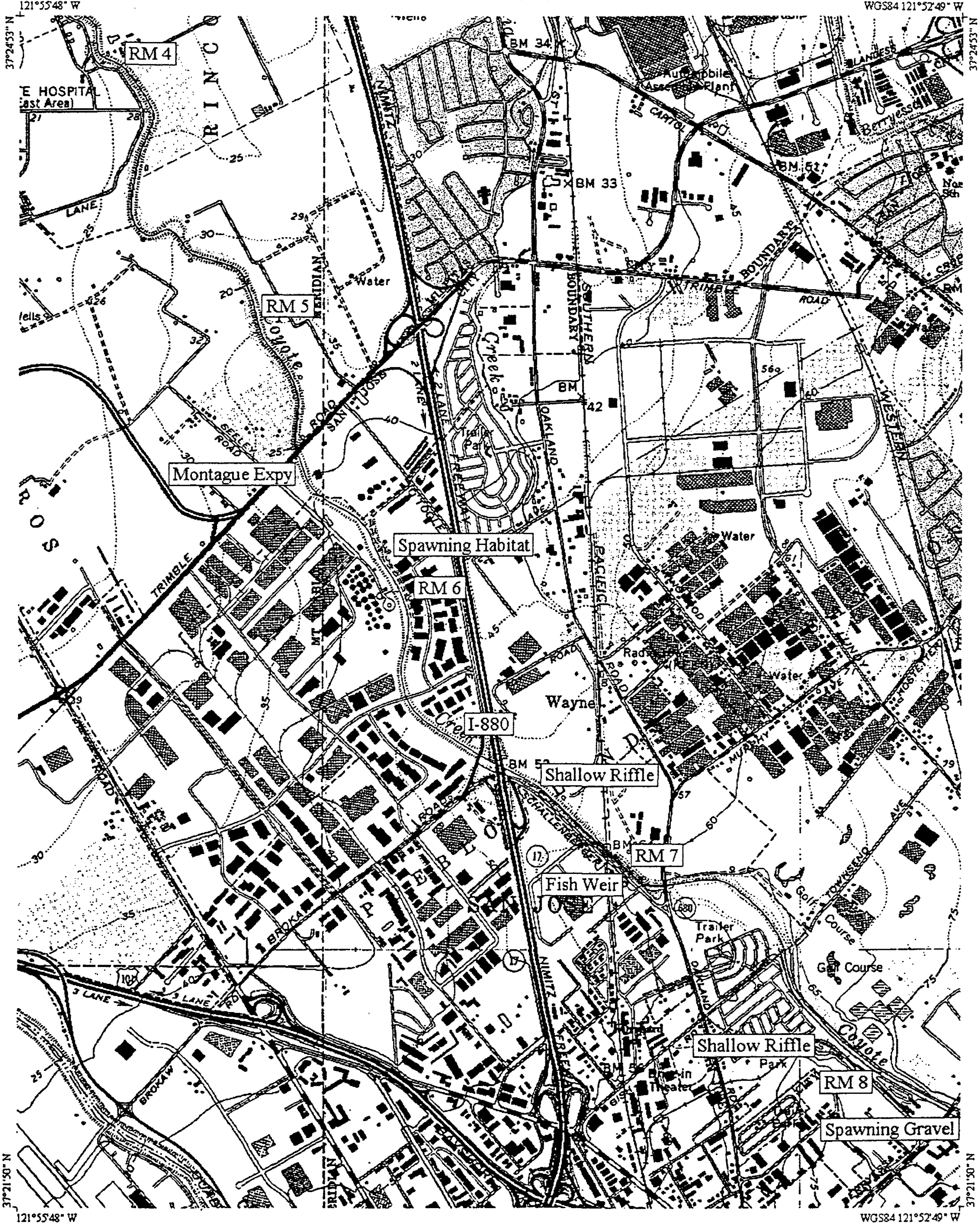

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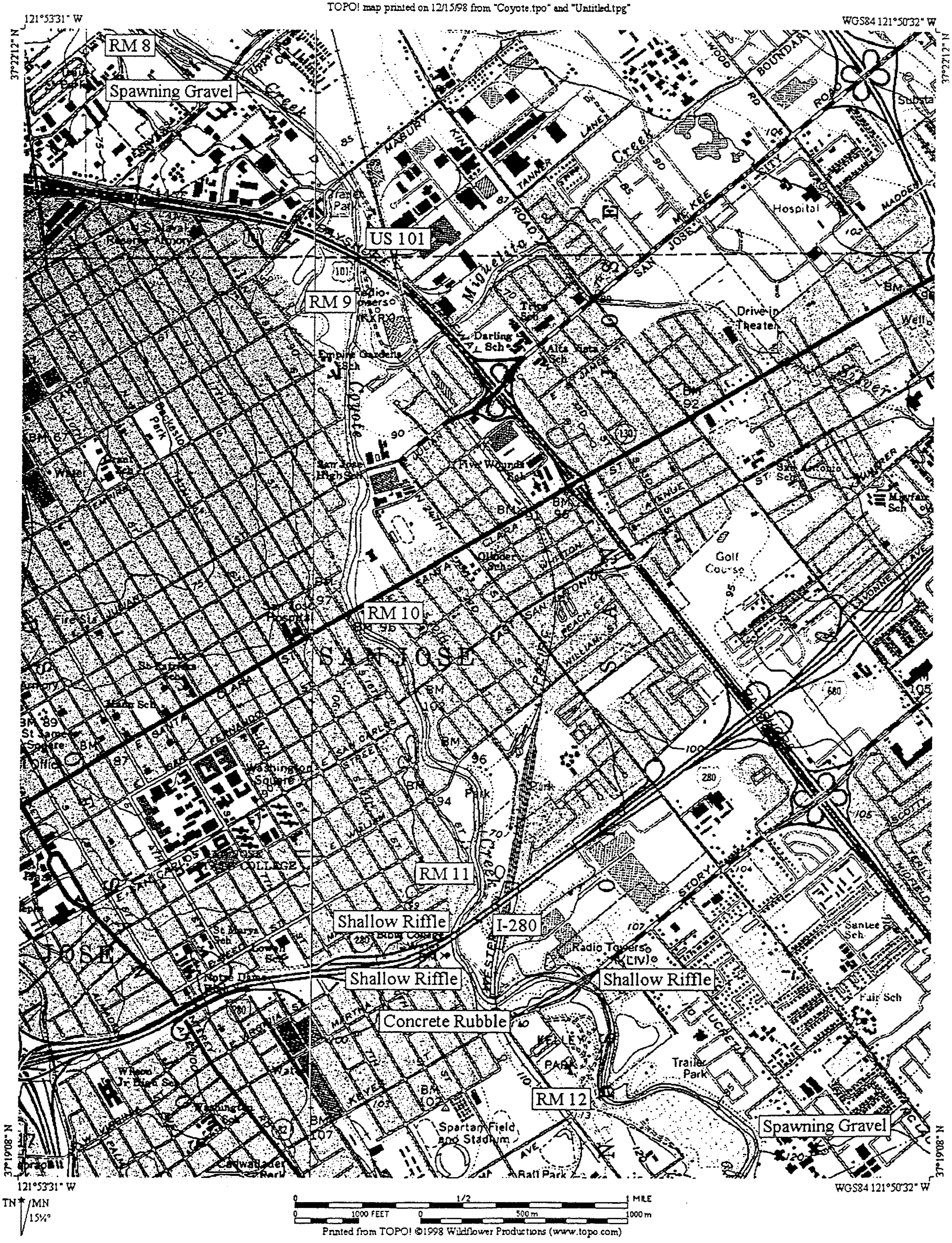

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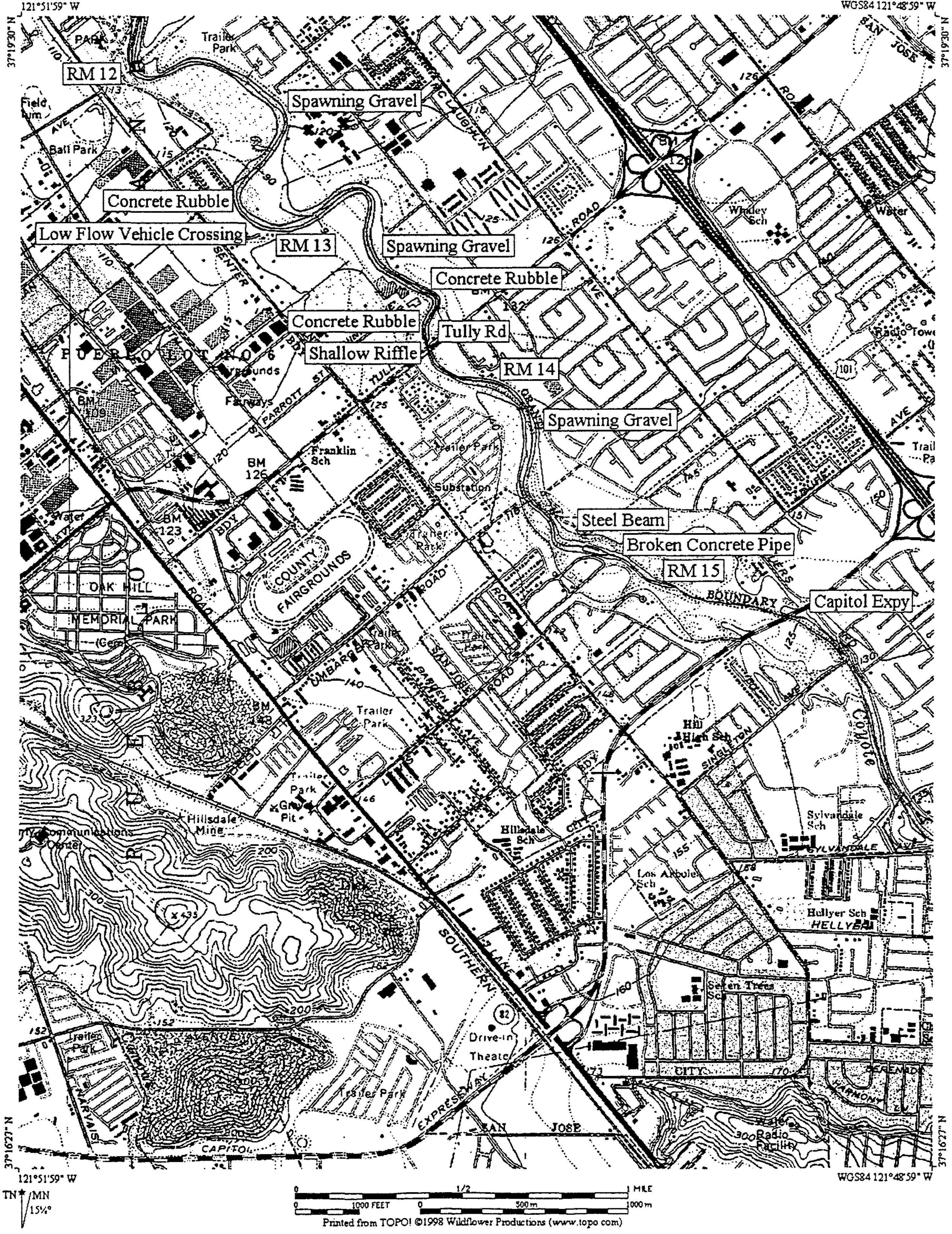

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